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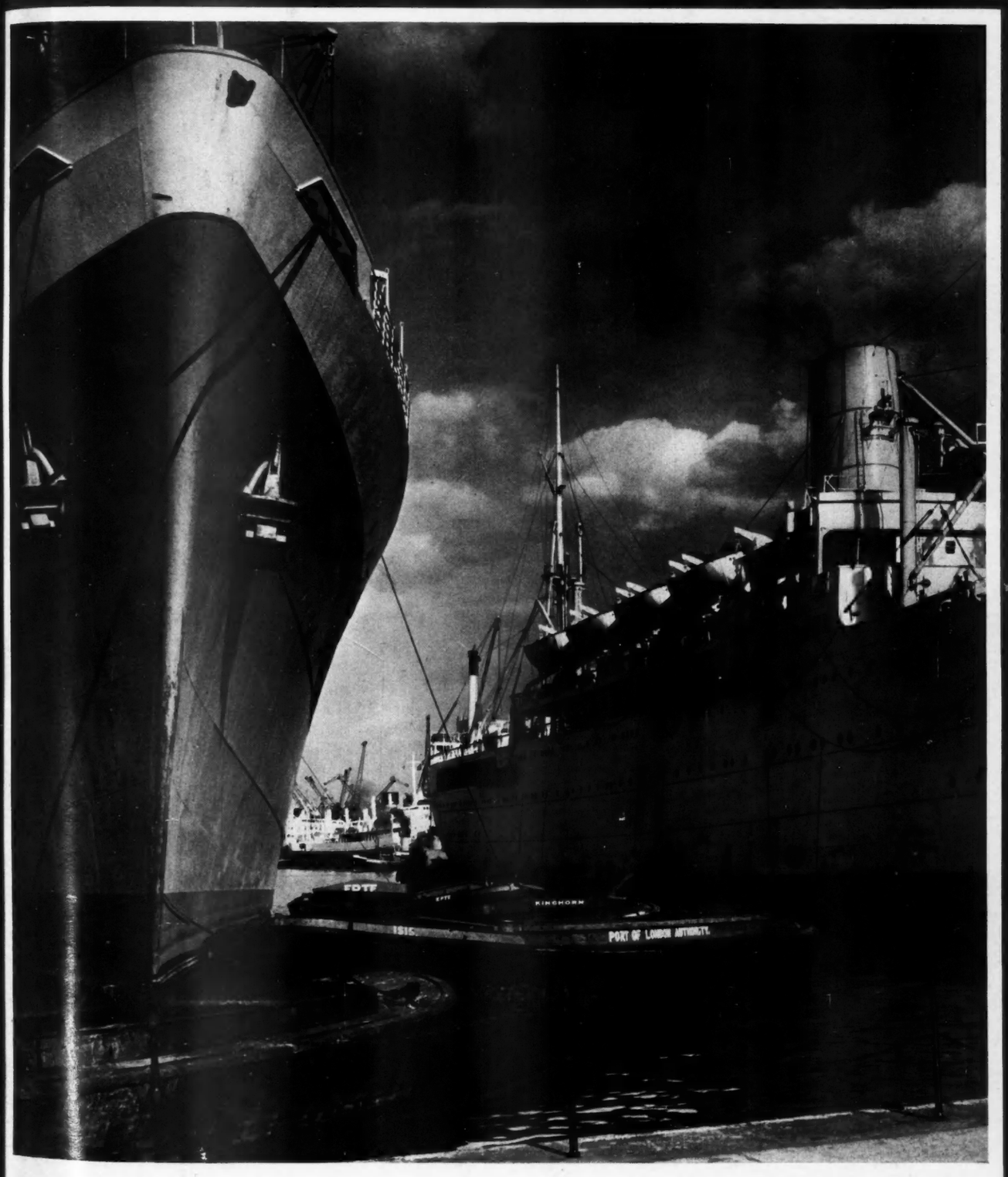

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ENGINEERING

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HUMAN RESEARCH

Failure in the industrial world can usually be traced to a failure in human relationships, and conversely success can seldom be sustained without successful human relationships. The force of this argument needs to be generally recognised. In the finest organisations, recognition of it is most marked at the higher levels of management: there is a pyramid of responsibility for acting on this belief, the few at the apex being the most conscious and active and, at the other extreme, the majority of workers enjoying the benefits of such an outlook though not themselves responsible for encouraging it. But if, at the top, there is blindness then no amount of aspiring leadership at lower levels can prevent the resulting friction and frustration.

The great significance of human relationships has been known for thousands of years, but it is only in recent times, since modern industry has created problems faster than they could be solved, that a need has risen for something more than is provided by the old humanitarian and religious principles. Economic troubles since the war have stimulated interest in the science of the subject, among industrial leaders themselves and among research workers who are aiming to find a scientific pattern in the mass of facts and opinions which confuse the issue.

The two approaches – of the industrialist and the researcher – are allied in the Committee on Human Relations in Industry, the chairman of which is Mr. A. B. Waring, chairman and managing director of Joseph Lucas (Industries), Limited. This committee was appointed in March, 1953, by the Medical Research Council and the Department of Scientific and Industrial Research to "examine current activities concerning the study of human relations in industry and to call attention to problems of special timeliness and promise on which research, including applied research and field study, might be undertaken or supported by the D.S.I.R., the M.R.C., or other bodies." The first report of the committee has recently been published (*Human Relations in Industry*, H.M. Stationery Office, price 1*s.* net).

One of the first difficulties which confronts a committee of this kind – a committee which directs the work of several groups but undertakes no research itself – is the difficulty of asking the right questions. What are the questions that industry wants the answers to? In a field of inquiry so involved as that of human relations it is difficult to know where to begin. The committee's terms of reference are not very helpful – "to call attention to problems of special timeliness and promise." To some extent, however, the committee's scope is defined by the terms under which funds for the work have been made available. One part of the money is coming from the Conditional Aid Programme derived from United States Economic Aid, and work financed from this source must be related to productivity and industrial efficiency, and limited to researches which show promise of applicable results at the end of the Conditional Aid period.

All the projects so far approved by the committee under this heading can be seen to comply with these requirements. Thus the factors influencing the effectiveness of incentive payment schemes are being studied at Birmingham University. At Manchester University an inquiry is being conducted into conventional norms of production which are determined not so much by technical or economic considerations as by the social attitudes of workers and management. Incentives for management are to be studied by the British Institute of Management; and at University College, London, the worker's understanding of the results of his efforts in terms of output or earnings will be examined. The second group of projects covers the characteristics of management organisation influencing productivity, particularly the flow of information in industrial organisations, the inspection process, and line supervision and the functional specialist. The subject of the third group is factors facilitating and restricting the introduction of new production techniques and methods, and of the fourth group, industrial education, training and promotion. The two projects which are being financed out of United Kingdom funds are one at the London School of Economics, on the employment of married women as part-time workers in a London factory, and one at Cambridge University on the effects of the introduction of automatic control principles on social attitudes and group relations in industry.

All these topics are clearly of great significance to engineering firms. The committee have chosen well; but as they are aware of "the extreme importance of relating the researches to the needs of industry," they would welcome suggestions from industrial organisations. What, indeed, are the right questions to ask the research workers? Perhaps it is necessary to discern the basic motives and aims of this work; to reject even "productivity" as the true goal, and to affirm the principle that the art of living in the environment of daily work is a noble end in itself. Seek this first, and productivity and all the other material benefits will be added.

Weekly Survey

FERGUSON TURNS TO CARS

For some time and in great secrecy Mr. Harry Ferguson has been directing his inventive genius towards the development of new types of cars, departing radically from traditional design. He has worked in close proximity to car manufacturers for many years and has probably been provoked into entering the industry by the cautious and conservative attitude of its management. Most new ideas concerning basic car design in recent years have emerged from the Continent, and Mr. Ferguson may well be the man to give back the lead to the British industry and to take advantage of the better production techniques available in this country. Mr. Ferguson's sale of his holdings in Massey-Harris-Ferguson, of which he was chairman, marked the severance of all his connections with agricultural engineering, 34 years after building the first prototype of an agricultural tractor with hydraulic implement control. He has sold his interests "in order to concentrate the whole of his resources behind the new inventions," presumably at present through Harry Ferguson Research. Massey-Harris-Ferguson, a world-wide concern formed only last August, will go on making and marketing the Ferguson tractors and full range of implements. The company have a 12-year contract for the manufacture of the tractor in this country with the Standard Motor Company, who will not therefore be affected by Mr. Ferguson's withdrawal.

Coventry car manufacturers were taken by surprise by Mr. Ferguson's move and there is much speculation as to his next step. He does not lack financial resources – his holdings in M.H.F. are valued at over £5 million at current market prices – and he would not find it difficult to attract backers if he wished. One of the more persistent rumours is that he may acquire a controlling interest in Standard, who would make the engine of the new car, though it is equally possible – and perhaps more appropriate in view of the revolutionary design of the car – that a new factory will be specially erected.

Prototypes of several cars – one a racing model with four-wheel drive and other unconventional features – have undergone road tests but no final decision has yet been made concerning the features of production models. The small car is likely to be a four-seater powered by an air-cooled 5-h.p. engine mounted at the rear. Following tractor practice, simplicity of design is to be the keynote. Suspension, transmission and braking, and body construction – a two-piece body – are said to depart radically from established practice in motor vehicle engineering. The price mentioned is £300 including Purchase Tax.

Any move by Mr. Ferguson will be watched with interest. He brings new ideas, a mind free from orthodoxy and a purse deep enough to absorb initial heavy losses. But no production car can be on the market for two years or more, even if a start were to be made now.

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STEEL IN SCOTLAND

The Scottish steel industry is not over-favourably sited. The supply of coking coal has given cause for concern; scrap which formerly came from Germany and the United States is no longer available in sufficient quantity; and the transport by rail of imported ore to the Motherwell works of Colvilles, Limited, is difficult and costly. Works with harbour facilities such as those at Middlesbrough, Port Talbot and Cardiff, where the ore can be discharged direct from the ships into adjacent blast-furnace stockyards, have an advantage which can be only partially off-set by rail transport schemes involving "buffer" storage at docks and the use of high-capacity wagons.

Easy access to raw materials is not, of course, the only consideration in the siting of a steel industry. Strategic and social needs are important as well as the potential market. Demand for steel in Scotland is a vital consideration, as well as the need to provide employment in the area and to disperse steel capacity for strategic reasons. Failure to provide adequate steel-making capacity in Scotland would hamper Scottish engineering and, indeed, restrict the industrial development of the United Kingdom as a whole. It is therefore welcome news that Colvilles have received the sanction of the Iron and Steel Board, and the Iron and Steel Holding and Realisation Agency, to proceed with a development programme which at a cost of £20 millions will raise Scottish ingot production to over 2 million tons. Dependence upon imported scrap will be reduced by the erection of a blast furnace which, with a hearth diameter of 25·5 ft. and capacity of 1,000 tons of pig-iron a day, will be one of the largest in the United Kingdom. Two batteries each of 35 coke ovens, boiler plant and power station are also to be provided, and the new steel-melting shop equipment proposed amounts to 400,000 tons. This could ultimately be increased to 800,000 tons if required. The new plant will employ 700 to 800 workers and occupy an area of over a square mile at Ravenscraig, to the east of Colvilles' Dalzell works and close also to the works of the Colvilles subsidiary, the Lanarkshire Steel Company. The rolling mills at both these works have been modernised in recent years, so the additions to ingot capacity will bring a corresponding increase in rolled products.

The Wishaw deviation branch of British Railways will form the main supply artery for raw materials. New ore-unloading installations, to be provided at General Terminus to supplement facilities at Rothesay Dock, will permit the simultaneous unloading of two of the largest ships in the ore-carrying trade. The supply of coking coal is not expected to present any difficulties in this carefully integrated plan. An additional 600,000 tons are required, but provided the Scottish miner plays his part this amount should be forthcoming.

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ENGINEERING COSTS

Sales of industrial internal-combustion engines fell in 1953. They amounted to 3·73 million brake horse-power, compared with 3·97 million brake horse-power in 1952. It is not therefore surprising that the turnover of the Ruston and Hornsby Group should have been slightly lower in the year to March 31, 1954, than in the previous year. The fall in profits was, however, more severe, amounting to £323,000 or 14 per cent. According to Mr. W. J. Ruston, the chairman, this was due to a rapid and general increase in costs and more particularly labour costs. Mr. J. E. V. Jobson, chairman of J. A. Prestwich and Company, whose firm's turnover in the same period had suffered from the particularly severe fall in demand for engines under 10 h.p., made the same complaint. He stated that costs due partly to increased prices for power, heat and light had increased by 14 per cent. against a reduced value of products of 15 per cent.

There is little evidence in the official indices that the rise in costs in 1953 has been proportionately greater than in other years. The index of prices of materials used in mechanical engineering was actually 3 per cent. lower than in 1952. The increase in wages which became effective at the end of 1952 brought an increase in the wage bill in the engineering, vehicle and metal goods industries of £1·6 millions a week, but there had been an increase of £1·33 millions a week the previous year. The annual net increases in the weekly wage bill of manufacturing industry as a whole actually fell from £2·96 millions in 1951 to £1·9 millions in 1952 and £638,000 in 1953. The absolute increase in costs is not, however, the important factor; price competition has now become keen for many products in world markets, and, as the experience of the makers of industrial engines in 1953 showed, industry can no longer afford automatic annual increments in wages unless these are more than offset by increased productivity. The need for restraint is recognised by many of the trades union leaders. Mr. Deakin, secretary of the Transport and General Workers' Union, recently stated that he believed very strongly and firmly in restraint in making wages claims. It remains to be seen, however, whether the enlightened trade union leadership can effectively control what Mr. Deakin described as the "great number of organisations" which forced their leaders to submit wages claims they had no hope of realising.

In the coming financial year the makers of industrial engines, like other employers in the engineering industry, have already had their wages bill increased by 6 per cent. as a result of the agreement made in the spring. Fortunately, sales have also risen; in April, 1954, they were valued at £3·65 millions, 15 per cent. more than in April, 1953, so that financial results may at least be no worse than in 1953. This circumstance may obscure but does not remove the need for wages restraint.

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THE PROBLEM OF INVESTMENT

The high level of prosperity which this country is at present enjoying without having to cope with a serious problem of inflation owes much to the ability of the community to save enough of its annual income to cover its investment programme. Until the present Government took office, much of the community's saving was achieved by large budget surpluses. To-day saving is done to an increasing extent by companies, firms and individuals who refrain from spending, and this fundamental change in the method of saving has by a fortunate combination of circumstances brought prosperity without inflation. Until recently the basic problem of the community was to save enough, now it is to establish some priority among the various claims for investment.

At the moment this country is enjoying something better than full employment, industrial output is still increasing at a very satisfactory rate, and costs have not risen so steeply as to impair seriously the stability of the balance of payments. It has become apparent, however, that the queue of industries seeking resources for expansion has now reached a dangerous length; dangerous because there seems to be no priority worked out and all expect to be able to fulfil their plans, now well advanced in the paper stage. The Atomic Energy Commission have been given priority in investment; the electricity and gas industries have prepared plans for a capital development programme amounting together to about £1,871 millions; the housing target is of the order of 400,000 houses a year over the next

12 months; and it is apparent from the increasing prosperity in many sections of the engineering industry that the recovery in the early months of this year is already being given added impetus by the investment allowance granted in the last budget.

The uneasiness about the strain which is going to be put on the nation's resources if the present claims for capital by various industries are not arranged in some order of priority, found expression earlier this month in the House of Commons when it became known that a motion to reject a second reading of the Gas and Electricity (Borrowing Powers) Bill was to be tabled by several Government supporters. Whatever may be the precise political significance of a move of this kind, it certainly draws attention to what may become a critical problem later this year. Before long the Government may be obliged to find some technique for encouraging those industries to expand which it considers desirable to stimulate, without, on the one hand, using fiscal means which will stimulate or damp down industry in general, and on the other hand without indulging in those physical forms of control which were popular before 1951. So far as the engineering industry is concerned, such selective treatment would perhaps stimulate or retard the expansion of one section as compared with another, but it would not impair the development of the industry as a whole. The engineering industry by and large is bound to benefit from an increase in the outlay of the capital goods industries, whatever the order of priority among them may be.

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CHINA TRADE

Sir Harry Pilkington, President of the Federation of British Industries and chairman of the newly-formed Sino-British Trade Committee (ENGINEERING, June 11, page 738) announced last Friday that the Committee have agreed to send a delegation to Peking in the autumn. This was the favourable outcome of discussions which took place between members of the Trade Committee and a trade delegation from China at present visiting the United Kingdom. The visit followed a preliminary exchange of views in Geneva, and was described by Sir Harry as a successful first step towards increasing British trade with China within the bounds imposed by United Nations restrictions at present in force. These restrictions effectively prevent the development of a substantial trade in engineering products, but the Chinese may have been looking ahead to freer trading conditions when they planned their tour of British industry. Included in the list of companies visited were Samuel Osborn, Henry Simon, Platt Brothers, Massey-Harris-Ferguson Company, Austin Motor Company, G.E.C., Marconi's Wireless Telegraph Company, and other engineering concerns (which constituted the majority of the companies visited).

Chinese interest in textile machinery was again stated to be low, despite the visit to Platt Brothers and talks with the Textile Machinery Manufacturers' Association. Interest in cycles was suggested by a meeting between the Chinese delegation and the British Cycle and Motor Cycle Manufacturers' and Traders' Association. British cycles may well find in China a vast market unsatisfied since Japanese cycles have been excluded. Discussions with the National Council of Building Industries and a visit to the Taylor Woodrow organisation indicate that the interest in prefabricated buildings may be one of those for early translation into orders.

The visit, though described as successful, appears to have achieved little more than the renewal of first-hand contact between China and British industry, which had hitherto been limited to visits by representatives of about 40 companies to East Berlin under the auspices of the British Council for the Promotion of International Trade. The Sino-British Trade Committee will follow up the discussions and advise firms wishing to trade with China, although there will be complete freedom to approach the Chinese direct at any of their trade offices, the nearest of which is in East Berlin. No office is likely to be opened in London by the Chinese, but it might become easier, as was hoped by Sir Harry Pilkington, for British business men to obtain visas to visit China. The Sino-British Trade Committee could not give any estimate of the effect of the discussions on the volume of trade with China, which, in the first five months of this year, amounted to only £4·6 millions, of which British exports accounted for only £1·75 millions.

* * *

ORDERS FOR OIL EQUIPMENT

Orders received by British companies for petroleum equipment showed a slight improvement in the first quarter of 1954, compared with the same period, 1953. This change may precede a check to the downward trend which has developed over the last two years. In 1951, orders placed with British oil-equipment manufacturers totalled almost £84 millions and reached £91 millions in 1952, when the oil-refinery building programme was at its height. In 1953, orders were down to £67 millions – a fall which was to be expected as the refinery-expansion programme decreased in Western Europe.

While orders for refinery equipment are likely to be concerned mainly with replacements for the next few years, there is still likely to be a considerable demand from the extraction and transport sections of the oil industry. A large development programme in well drilling and development is still in progress in the United States and it can be expected that a considerable turnover will be forthcoming from this source. About 90 per cent. of the world's drilling and development programme is being undertaken within the United States as the American oil industry drills more and deeper wells to add to its oil reserves. Dollar orders will not be easy to obtain, but the market for equipment is certainly there and British industry can increase its share.

In transport, a very large programme in oil and natural-gas pipe laying is in hand, both in North America, in Europe and the Middle East. The order which Stewarts and Lloyds, Limited, obtained recently for 350 miles of 16-inch seamless natural-gas pipe amounting to more than 40,000 tons at a value of £2 million is an indication of the scope which still exists for the petroleum-equipment industry. Not all manufacturers can benefit from the change in emphasis from refining to extraction (an emphasis which has never been apparent in the United States) but the completion of the refinery programme in Western Europe is certainly not to be construed as meaning poorer prospects for the oil-equipment industry as a whole in this country.

* * *

FUEL AND POWER PLANS

The likely developments in the supply of gas, electricity and other fuels in the next few years were referred to by the Minister of Fuel and Power, Mr. Geoffrey Lloyd, when he moved the second reading of the Gas and Electricity (Borrowing Powers) Bill in the House last week. He said that the Bill increased by large amounts the limits of the gas and electricity industries' borrowing powers, but simultaneously exercised a controlling influence on the capital-development plans of the two industries until 1960.

Under the Bill, the Minister said, the borrowing limits of electricity were raised from £700 million to £1,400 million, and of gas from £250 million to £450 million. Together with monies contributed by themselves, the industries would now be able to undertake capital works up to a joint value of about £1,800 million in the next six years. The conscription of such large sums for one section of industry at the expense of other deserving sections was severely criticised in the ensuing debate and is discussed in another "Weekly Survey" note. The work envisaged must give rise, however, to many substantial contracts to the engineering industry in the immediate future, particularly to civil engineering contractors and the heavy-plant manufacturers.

The Minister described at some length the changes which were taking place in the fuel and power industries. He intimated that developments in atomic power were progressing so rapidly that the construction of nuclear power stations of an advanced type would probably be undertaken before 1960. With the object of saving coal, many estuary-located power stations were being installed with dual-firing boilers so that fuel oil could be substituted for coal. Also, several plants were now under construction – or the contracts out to tender – for the production of a fuel gas by a cracking process from crude oils; these would effect a considerable saving in the high-grade coals at present used in the gas industry's carbonisation plants. And, fourthly, he referred to the search – already showing signs of success – for natural gas, particularly in the counties of Yorkshire and Kent, and mentioned in a "Weekly Survey" note a fortnight ago.

Significantly, the Minister also drew attention to the heavy increase in capital costs with respect to labour charges in the fuel and power industries, a change to be noted in other fields and illustrated by the intended purpose of many of the exhibits – elimination of labour charges – at the Production Exhibition reported elsewhere in this issue.

* * *

BRIDGING A GAP

Who can measure the use that industrial firms make of the work carried out at research establishments financed or supported from Government funds? In 1952 – the last year for which figures are available – the total expenditure of the Department of Scientific and Industrial Research was £5,773,303. The National Physical Laboratory received the largest individual share, amounting to £860,842. It is, of course, impossible to assess the extent to which this expenditure benefits industry, but it is evident that in official circles there is a growing conviction that more could be done to bridge the gap between the research staffs and the engineers in industry who are supposed to benefit from their work.

A lead has now been given by the Director of the N.P.L., Sir Edward Bullard, F.R.S., who has appointed two liaison officers to work with industry – Mr. E. I. Brimelow, M.Eng., A.I.M., and Mr. A. J. Garratt, M.B.E., B.Sc., A.Inst.P. Very little of this kind of work has so far been done, but it has great possibilities. The liaison officers will watch N.P.L. results from the point of view of potential users; they will co-operate closely with the research associations. It will be interesting to see how the pattern of their work evolves.

LOCH SHIN HYDRO-ELECTRIC SCHEME

Contracts Awarded

Further details have been given by the North of Scotland Hydro-Electric Board on their Loch Shin project. The waters of Loch Shin and tributaries, the River Cassley, the River Brora and other streams in the County of Sutherland will be used for the annual production of about 151,000,000 units. The scheme, which will harness the water power resources of an area of about 250 square miles, is estimated to cost approximately £8,000,000. The work involved includes the construction of five power stations with a total capacity of 40 MW and four dams.

Loch Shin will be enlarged by building a dam north of Lairg in which will be incorporated a generating station with an installed capacity of 3,500 kW discharging into a small loch below. A second dam will be built across the river Shin about a mile below the main dam. From the reservoir thus formed, water will be led by an aqueduct to the main generating station near Inveran, which will have an installed capacity of 23,000 kW. Both dams will include provision for the passage of fish. Water from the upper River Brora will be diverted by a weir at Dalnessie on the River Brora and led by an aqueduct into a tributary of the River Tirry.

The Cassley station on the southern shore of Loch Shin near the western end will use water brought by tunnel from the upper Cassley and streams which feed it. The station's capacity will be 7,500 kW.

There are two subsidiary developments to the north-west of Loch Shin. One consists of a dam to enlarge Feur Loch, an aqueduct and a power station with a capacity of 1,000 kW situated on the southern shore of Loch Merkland near Garvault. A second station is to be on the opposite side of Loch Merkland and will have a capacity of 5,000 kW. It will be fed from a reservoir formed by joining three small lochs.

George Wimpey and Company, Limited, Edinburgh, have been awarded the contracts to build the Shin generating station and tunnel and the Lairg dam. The tunnel will be five miles in length. Lairg dam will be 38 ft. high and 1,370 ft. long.

R. J. McLeod (Contractors), Limited, Glasgow, have been given the contract to construct the Cassley generating station on the south shore of Loch Shin near Creanich, the aqueducts which will collect water from the headwaters of the River Cassley, and a 2½-mile tunnel which will lead it to the power station.

The value of the contracts is approximately £5,000,000.

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TRAINING GRADUATE ENGINEERS

Since the inauguration of their graduate apprenticeship scheme in 1902, the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, have trained more than 3,000 engineers, and to indicate the scope and aims of the two-year programme of practical and theoretical instruction provided by the scheme, a booklet entitled *The Training of the Professional Engineer* has been published.

The course of post-graduate training covers the fields of light and heavy electrical engineering and the branches of mechanical engineering concerned with steam and gas turbines, and is divided into three phases. The first is devoted to workshop practice in the basic processes of engineering production, the second to general mechanical and electrical work and the third to a broad technological training in design, production, research or sales engineering in accordance with the student's choice of future occupation.

THE INSTITUTION OF ELECTRICAL ENGINEERS

SUMMER MEETING IN THE WEST COUNTRY

The Summer Meeting of the Institution of Electrical Engineers was held at Bristol and Cardiff from Monday, June 28, to Friday, July 2, about 250 members and their ladies being present under the leadership of the President (Mr. H. Bishop). This is the first time the meeting has taken place in the West Country since 1920.

A number of visits to places of technical interest were paid, among which mention may be made of the Portishead "B" power station in the South Western Division of the British Electricity Authority. This station, which is now under construction, will have an ultimate capacity of 360 MW, the equipment comprising 12 300,000-lb. boilers, which will be fired by pulverised South Wales coal and from which steam will be supplied at 900 lb. per square inch and 900 deg. F. to six 60-MW turbo-alternators.

A special feature of the station is the circulating water system, which consists of four inverted horseshoe-shaped culverts. These culverts have been driven out to a dredged channel in the Severn Estuary and are about one-third of a mile long. They will be concrete-lined; about 70 per cent. of this work has been completed. On account of the extremely high tide range (over 51 ft. between the highest and lowest recorded tides) the inverts are at −37·5 O.D. level. Each culvert is intersected by a 21-ft. diameter pit, 70 ft. deep, which will contain two 72-in. wide vertical band screens with variable-speed electric drives. The hydraulically-operated valves and pipework will be arranged so that any culvert can be used as either an inlet or discharge, thus facilitating cleaning. There will be four centrifugal pumps, each with an output of 25,100 gallons per minute in each pump pit. These pumps will be electrically driven by motors through a 75-ft. shaft.

Part of the site of the Dudbridge substation and depot in the central Gloucestershire sub-area of the Midlands Electricity Board, which was also visited, is utilised as a linesman's school and on the occasion of the inspection demonstrations were given of a pothole borer and of dry jointing. The equipment of the substation consists of two 12·5-MVA 33/6·6-kV transformers and is used for supplying Stroud and the neighbourhood.

CRANE MANUFACTURE

Among the works inspected were those of Stothert and Pitt, Limited, Bath. These are now almost entirely operated by electricity obtained from the mains, although it is of historical interest to state that 50 years ago the necessary power was generated by a Belliss and Morcom Siemens set, which supplied direct-current at 110 volts. As is well known, cranes form one of the principal products of this firm and these are erected in what is known as the Newark works. The adjacent Victoria works include a foundry, structural, welding and machine shops, as well as assembly bays for pumps, deck machinery, concrete mixers and quarry plant.

PACKAGING PLANT

The application of electric drive to machines used in the paper converting and packaging industry was exemplified at the factory of Strachan and Henshaw, Limited, Bristol, by a perforating tubing machine 98 ft. long by 17 ft. wide by 13 ft. 6 in. high, which has been designed for the production of multi-wall tubes. These tubes, when sealed at one end on a second machine, are used as containers for cement, fertilisers, plaster and other products. The main machine is driven by a 40-h.p. variable-speed commutator motor as well as by a centrifugally-coupled 5-h.p. crawl motor, a number of special control features being incorporated. There are also several auxiliary motors, and an automatic device enables register to be maintained between the print on the outer ply and the tube cut-off.

Another machine on view was a rotary perfecting press in which rubber printing plates are employed as well as a modified form of heat-set ink. This is mainly intended for printing pocket books and similar publications.

ZINC REFINING

Those visiting the works of the National Smelting Company, Limited, at Avonmouth, were able to see the various processes whereby zinc concentrates are treated to produce "Crown Special" zinc of 99·9 per cent. purity, the sulphur thus removed being sent to the acid plant as an 8 per cent. concentration of sulphur dioxide in air. The degree of mechanisation is high, the works being supplied through eight substations from which power is derived for driving mills, briquetting plant and presses. Heat from the coking furnaces, in which the volatiles are removed, is utilised for raising steam.

The equipment in the acid plant includes scrubbing towers and electrostatic precipitators. After cleaning, the sulphur dioxide is dried by strong acid and converted into sulphur trioxide, which, in turn, is absorbed in strong sulphuric acid.

The versatility of electric power in the manufacture of a wide range of equipment was also made apparent during the inspection of the works of the Bristol Aeroplane Company, Limited, at Filton, of W. D. and H. O. Wills' tobacco factory in Bristol and in the manufacture of coloured-printed waxed wrapping and cartons by E. S. and A. Robinson, Limited, in the same city, as well as those of J. S. Fry and Sons, Limited, at Somerdale. A small party were received by the Vice-Chancellor of the University of Bristol and were given the opportunity of seeing the progress that is being made in the construction of the new engineering laboratories and of the work that is being done in the field of cosmic physics.

Those whose bent was not entirely technical visited the Severn Wild Fowl Trust, as well as the National and Welsh Folk Museums at Cardiff, places of historical interest in Bristol, including the Zoo, and the Cider Research station at Long Ashton. The social functions included a reception by the Lord Mayor of Bristol (Alderman G. G. Adams) and the Lady Mayoress.

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MAKING LAMINATED PLASTICS: ERRATUM

In the article on Thomas de la Rue's factory at Tynemouth, "Making Laminated Plastics," on page 18 of the July 2 issue, we stated incorrectly that the large impregnating and drying machine was constructed by Mitchell Engineering Limited, Peterborough. It was, in fact, supplied by the the chemical engineering firm, L. A. Mitchell, Limited, 37 Peter-street, Manchester, 2.

PERSONAL

MR. HARRY FERGUSON has resigned his positions as chairman and as a director of Massey-Harris-Ferguson Ltd., Coventry, in order to develop a number of new inventions – outside the agricultural machinery field – upon which he has been working for many years. MR. J. S. DUNCAN, who directs the world-wide activities of Massey-Harris-Ferguson Ltd. with the title of President, now becomes chairman and President of the organisation (see also page 66).

MR. R. W. FOXLEE, C.M.G., C.B.E., M.I.C.E., late engineer-in-chief to the Crown Agents, and engineering adviser to the Secretary of State for the Colonies, joined Coode and Partners, chartered civil engineers, 9 Victoria-street, London, S.W.1, as a consultant as from July 1.

MR. J. D. THORN, M.A., A.M.I.Mech.E., is to take up the appointment of chief engineer, engine department, Ruston and Hornsby Ltd., Lincoln, on July 19, in succession to MR. I. WANS, A.M.I.C.E., M.I.Mech.E., M.I.Mar.E., who is resigning from the company. For the time being, Mr. Thorn will continue in his present capacity as chief research engineer.

MR. J. WRIGHT, O.B.E., F.R.Ae.S., director and general manager of the Dunlop Rim and Wheel Co. Ltd., Coventry, has been appointed a director of the Dunlop Rubber Co. Ltd.

MISS G. L. ENTWISLE, A.M.I.E.E., one of the first women electrical engineers in this country, retired on June 30 after 38½ years of service with Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17.

MR. G. D. L. GOSLETT, O.B.E., MR. C. B. INNES and MR. D. L. IRWIN, JNR., have been elected to the board of the Ruberoid Co. Ltd.

MR. R. J. SHELL, B.Sc. (Eng.), A.M.I.Mech.E., has been appointed proving engineer on the technical staff of C.A.V. Ltd., Acton, London, W.3.

MR. J. S. ARMSTRONG has been made marine representative in the technical department of Jenolite Ltd., 13-15 Rathbone-street, London, W.1.

The Court of the Salters' Company, 36 Portland-place, London, W.1, have elected MR. G. HETHERINGTON, of King's College, Newcastle-upon-Tyne, to be a Salters' Fellow for the year 1954-55, and have extended the Fellowship held by MR. P. P. MANNING, of the University of Leeds for a second year. Also elected to be Salters' Scholars, for the year 1954-55, are MR. C. P. BROWN, of the University of Nottingham; MR. M. MCLEMAN, of Imperial College, London; MR. A. D. SHIPMAN, of the University of Bristol; MR. H. SPOEL, of the University of Oxford, and MR. W. L. WILKINSON, of the University of Cambridge.

MR. A. W. PAGE, M.B.E., T.D., M.I.P.E., has been appointed London manager of the Igranic Electric Co. Ltd., in place of MR. N. V. BALDWIN, T.D., M.I.E.E., who is on his way to Johannesburg to take up his appointment of managing director of Brookhirst-Igranic S.A. (Pty.) Ltd., the South African subsidiary company of the Electrical Division of Metal Industries Ltd., Victoria Station House, 191, Victoria-street, London, S.W.1.

MR. ROBERT HILL, deputy personnel manager with Baker Perkins Ltd., Peterborough, has retired.

MR. WILLIAM DODDS, who joined the Mercantile Dry Dock Co. Ltd., Jarrow, Co. Durham, in 1920 and became secretary in 1939, has retired.

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BUSINESS CHANGES

COMMERCIAL PATENTS LTD. have changed their address to 601 Grand Buildings, Trafalgar-square, London, W.C.2. (Telephone: TRAfalgar 3932.)

Owing to the retirement of MISS G. BINGHAM as assistant secretary of THE NEWCOMEN SOCIETY all communications, on and after July 28, should be addressed to the honorary secretary, the Newcomen Society, Science Museum, Exhibition-road, London, S.W.7. MRS. I. BARTHOLOMEW has been appointed assistant secretary. (Telephone: KENsington 1793.)

DEWRANCE & CO. LTD. announce that their Cardiff office has now been transferred to larger premises at 4, Museum-place, Cardiff. (Telephone: Cardiff 2[illegible]807). MR. D. G. SEYMOUR is the company's manager for this area.

SMALL AND PARKES LTD., Hendham Vale Works, Manchester, 9, inform us that on and after July 20, their Belfast service depot will be at 67 Dublin-road, Belfast. (Telephone: Belfast 28967.) The area manager is Captain J. Douglas.

Obituary

MR. F. H. JONES

Organisation of the Gas Industry

We note with regret the death of Mr. Frank Harding Jones which occurred in London on July 9, at the age of 81. He was well known in the gas industry and was the son of the late Mr. Henry Edward Jones who served as President of both the Institution of Civil Engineers and the Institution of Gas Engineers. Mr. F. H. Jones was educated at Rugby and subsequently became an articled pupil of Sir John Wolfe Barry, to whom, on completion of his pupilage he was appointed assistant engineer. He was then engaged on the construction of the Tower Bridge and on other engineering works including the Glasgow Subway, or underground railway. In 1896, he became a partner in his father's consulting engineering practice, but gradually devoted all his time to the organisation and management of gas and water companies. His work extended not only to the United Kingdom but also to France and South America through the European Gas Company, the Montevideo Gas and Dry Dock Company Limited, and the Primitiva Gas Company, Limited. Mr. Jones was appointed a director of the South Metropolitan Gas Company in 1912 and became President of the company and chairman of the board of directors in 1937. He was one of the pioneers who negotiated and carried through to completion the amalgamation of many gas companies.

Although 66 years of age when the late war began, he continued to guide all the companies of which he was chairman until the industry was nationalised in 1949. Mr. Jones was elected a member of the Institution of Gas Engineers in 1903 and of the Institution of Civil Engineers in 1909. He was chairman of the British Commercial Gas Association in 1928 and 1929 and President of the National Gas Council for 1945 to 1947.

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We regret also to report the death of:—

MR. H. ROSS HOOPER, O.B.E., M.A., M.I.C.E., whose death occurred on July 6 at the age of 90. In his earlier days he was responsible for railway and port work in both the Argentine and in Canada. For 19 years he was an Engineering Inspector at the Ministry of Health and, in 1926, entered into partnership with Mr. Parker Pearson, M.I.C.E., as consulting engineers practising in both Victoria-street, London, and from Chippenham, Wilts. Mr. Hooper was an official representative of the United Kingdom at the European Conference on Rural Hygiene and Sanitation held at Geneva in June, 1931.

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ALL-BRITISH TRADE FAIR AT COPENHAGEN

With the full support of the British and Danish Governments, an all-British trade fair and exhibition will be held at Copenhagen from Thursday, September 29, to Sunday, October 16, 1955. As in the case of the previous British fairs in 1932 and 1948, next year's exhibition will be organised by the British Import Union of Denmark in collaboration with the Federation of British Industries.

Sites chosen for the event are the Tivoli Gardens and the Forum, and existing accommodation there will be supplemented by temporary structures of British manufacture. The Federation is making available the services of its subsidiary company, British Overseas Fairs Limited, which was formed last year to organise the forthcoming British Trade Fair at Baghdad. Mr. D. A. Lamb, the company's exhibition organiser, has been appointed manager of the Copenhagen Fair.

Inquiries should be addressed to the British Overseas Fairs Limited, 21 Tothill-street, London, S.W.1.

Letters to the Editor

HEAT CAPACITY OF LAMINATIONS

Effect of Insulation Films

SIR, In the note on the above subject published in the issue of ENGINEERING of June 18 (page 781) by Mr. L. G. A. Sims and Mr. K. L. Morphew, major consideration is given to the influence of the oxide scale on the surface of 4 per cent. silicon transformer laminations. It is assumed in considering this problem that the oxide is mainly Fe_2O_3. Winterbottom* has shown that it is more probable that the bulk of the oxide layer, and certainly that portion in contact with the iron, is FeO. He estimates that the scale formed at 900 deg. C. on heated iron consists of a layer of FeO amounting to 80 per cent. of the thickness in contact with the iron with a layer of Fe_2O_3 in contact with the air amounting to only 2 per cent. of the total thickness, and an intermediate layer of Fe_3O_4 amounting to 18 per cent. of the total thickness. It has not been determined what effect 4 per cent. silicon in the steel would have on the type of oxide layer, but it is certainly not likely to effect the ratio of these oxides though an equivalent percentage of iron silicates or SiO_2 would undoubtedly appear in the film.

Quite apart from these considerations, however, it is some years since the electrical sheet industry of this country supplied any hot-rolled transformer sheets not pickled free from scale, and this is so well known in the industry that the price of these grades of sheet automatically includes the cost of pickling.

The cold-rolled oriented transformer steels produced recently are also pickled free from oxide after a preliminary hot rolling during the course of manufacture. It is clear, therefore, that in the present-day conditions there is no point in speculating about the effect of an oxide scale on the heat capacity of laminations. There is, of course, always an insulation applied to sheets for transformers, which might be kaolin base, core plate varnish, or paper, and in the case of cold-rolled oriented steels, it is normally an extremely thin special type of insulation fused into the surface which will withstand low-temperature annealing.

It is the effect of these insulation films which should be taken into consideration by anybody studying this problem, and not the effect of a layer of iron oxide.

Yours faithfully,

E. MARKS.

Richard Thomas and Baldwins Limited,
Kidderminster.

June 24, 1954.

* A. B. Winterbottom, *Journal of the Iron and Steel Institute*, vol. 73, page 256 (1931).

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COURSE ON AIRCRAFT ELECTRICAL SYSTEMS

A five-day vacation school on aircraft electrical systems is to be held in the Electrical Engineering Department of the Imperial College of Science and Technology, City and Guilds College, Exhibition-road, London, S.W.7, from Monday, September 20, to Friday, September 24. The course aims at defining the scientific principles underlying the design and application of all forms of aircraft electrical equipment, and is intended primarily for engineers with some experience in this field. To foster informal discussion, the number participating will be restricted to about 60. The fee for the school, including luncheons and transport, etc., will be eight guineas. The course will be opened by Sir Frederick Handley Page, C.B.E., and will include a visit to the Vickers-Armstrongs works.

Fig. 1 This automatic loading and ejecting device has been fitted to a lathe used for machining pistons.

Fig. 2 A small machine for rapidly assembling needle rollers in transmission gears.

THE PRODUCTION EXHIBITION

REDUCING LABOUR COSTS

A new exhibition was opened in London last week. Its title is the Production Exhibition and it occupies the ground floor and part of the balcony of the National Hall, Olympia, from July 7 to July 17. The exhibition has been organised by Andry Montgomery, Limited, who are associated with the firm which has organised the Building Exhibition for the past 60 years. In support, they obtained the help of the Institution of Production Engineers.

The exhibition illustrates the work of the British Productivity Council and endeavours to portray graphically and by other means what is meant by higher productivity and how it can be achieved. It is hoped by the sponsors that the exhibition will go some way towards breaking down the tendency of firms to work in "closed cells" and will produce what Sir Walter Puckey, President of the Institution of Production Engineers, has referred to as the "cross fertilisation of ideas."

The Ford Motor Company have by the far the largest single display, having uprooted their production lines at Dagenham to bring working machines to the exhibition. Those which they could not move they are showing with the aid of television on screens erected in the hall. Many of the exhibitors are displaying models which show the layout of their factories, particularly their machine shops; photographs and charts illustrate the training schemes which they are running; examples of standardisation and simplification are on display together with illustrations of method study and work measurement.

Other exhibitors, however, have stands arranged in much the same manner as they would adopt at a normal trade exhibition. More than 100 exhibitors represent many sections of industry covering scientific research and development, standardisation, new methods and processes, new machinery, materials and metals.

RADIATOR CORE ASSEMBLY

The most outstanding selection of exhibits at the exhibition is undoubtedly that on the stands occupied by the Ford Motor Company, Limited, Dagenham, Essex. All the machines and methods shown by them are actual working examples transferred from the company's production lines and exemplify the present movement towards greater productivity. To allow for the loss in production due to absence of one of the machines from their production lines a stock of the components concerned – radiators – had to be built up. This particular machine, which is used for assembling radiator cores, was designed and made by the company.

The radiator which it produces is designed on the tube-and-fin principle. Before the introduction of this machine the fins were laid in a fixture by hand and a comb placed between each fin to ensure correct spacing. When the requisite number of fins had been loaded, the operator assembled each tube by hand until the radiator core was complete.

In the present mechanical assembly, a roll of copper strip is fed from a spindle at one end of the machine, over guide rollers to a chamber, which is suspended on springs. As the amount of copper strip in the chamber reaches a certain weight, it causes the chamber to be lowered; this action operates contact switches and stops the feed. The strip is then drawn from the chamber by rolls and fed to a press tool, where the tube holes are pierced and lanced. The fins are also cut to the correct length and pass along a belt to the assembly fixture. As each fin falls into position in the fixture it is followed by a comb-type spacer, and at the end of the cycle the stack of fins and spacers is pushed by a ram to the final assembly position. While the fins are being loaded the correct number of tubes are also automatically sorted and loaded into a fixture to give the required spacing. The fixture is then moved into position below the fins. The assembly is completed by the movement of a single ram, which pushes the tubes into the fins.

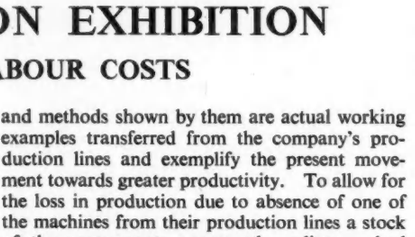

Fig. 3 An electric light bulb on the operator's wrist enables his movements to be recorded on a photographic plate.

The time required to complete an assembly by the old method was 17½ minutes, compared with 3½ minutes by the new machine. During the exhibition, a raised platform and mirrors have been erected above the machine to enable visitors to follow closely the movements of the various stages in the assembly.

Among other exhibits is a lathe, equipped with an automatic loading and ejecting device, illustrated in Fig. 1, above, for machining pistons. The pistons are placed on an inclined rack which allows the components to be dropped into one of a series of slots cut around the periphery of an indexing plate. The tailstock ram which carries the cutter head loads the piston into the collet and machines a register in the base of the piston. As the ram retracts, the piston is ejected on to a gravity chute and the next piston in the rack is automatically loaded.

NEEDLE ROLLER ASSEMBLY

A small machine, which could find a use in many shops, has been produced by the Ford company as is shown in Fig. 2, above. It has been designed for the automatic assembly of needle rollers in both ends of a transmission gear. The needle rollers are fed into a hopper and find their way through a slot to a hollow mandrel. A small rubber ball retains the rollers in position around the mandrel while it is moved forward to force the needles and rubber

ball into the bore of the gear. The actual transfer of the needles to the transmission gear takes less than a second.

TRACING AN OPERATOR'S MOVEMENTS

We illustrate, in Fig. 3, a method used by many firms, in particular, at the exhibition, by Black and Decker, Limited, Harmondsworth, Middlesex, who are showing their range of portable electric tools, to portray the saving of both time and effort in the use of electric tools as compared with hand-driven tools. The white line in the illustration shows the movement of the operator's hand during a series of time and motion photographic tests. These were performed in a darkened room with a small electric bulb attached to the operator's wrist. Each operation was timed by means of a stop watch and the camera synchronised so that the shutter opened and closed at the beginning and completion of each experiment.

To drill three ¼-in. holes in a piece of $\frac{3}{16}$-in. mild-steel plate, it took 279 sec. by hand and the effort required was indicated by the pattern of the light whirls. The same operation with a ¼-in. heavy-duty drill in a bench stand took only 36 sec., the light tracing being only a thin vertical line, indicating the small degree of movement – and therefore operator fatigue – involved.

CHECKING TURBINE BLADE CONTOURS

Taylor, Taylor and Hobson, Limited, Stoughton-street, Leicester, are showing two pieces of apparatus which they have developed recently. One of these is a projector and device which will mark one or more white lines around the surface of a turbine blade, in a plane parallel to its mounting. The blade is inserted in a 4-in. diameter ¾-in. thick flange, and then placed in the projector with the axis of the blade parallel to the axis of the optical system. A white line is then scribed at the selected sections along the blade and the surface of the blade is illuminated in the neighbourhood of the lines. A large aperture lens projects an image of the white line on to a screen at 10 × magnification, giving the outline of a single section.

By means of a patented mirror system, it is also possible to project two sections on to the screen at once at the same magnification, so that the relative orientation of those two sections is maintained and they can be checked against suitable diagrams on the screen. This can be seen in the illustration showing the machine, Fig. 4, above. Departures from the correct position of these sections in relation to the mounting can also be checked for lateral and vertical displacement by moving the screen in two directions at right angles by means of the joystick type of control lever. These two movements are shown in thousandths of an inch by dial indicators in front of the screen. The twist of the sections can be measured by rotating the blade in its mounting to match the pattern on the screen, and the errors measured to within one minute of arc.

The equipment will project sections of shrouded or unshrouded blades up to a blade width of 2½ in. and sections along the blade up to 8 in. from the tip of the blade. In those cases where it is required to project two sections, these two sections can be projected at a maximum separation of 7 in. and a minimum separation of 1½ in. The screen can be of ground glass or may be a photographic plate up to 30 in. by 24 in., but the maximum usable area on this screen will be a circle of 27 in. diameter, flattened at the top and bottom to a height of 20 in.

The other instrument of particular interest shown by this company is also for the inspection of turbine blades. It is a microscope designed for viewing the leading and trailing edges of turbine blades. It is simple and carries a clamp for holding the blade. The magnification given is 40.

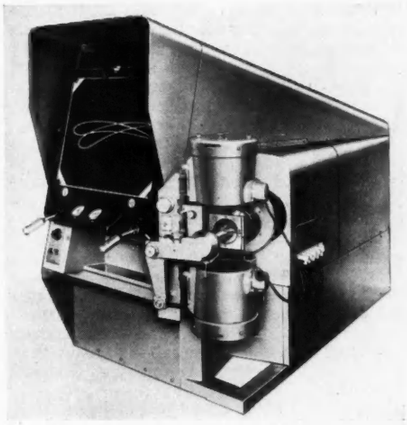

Fig. 4 This projector is used for the rapid and accurate inspection of turbine blades.

FUEL CELLS

The Ministry of Fuel and Power are occupying a stand on which a number of models are displayed. The models themselves show some new developments which, it is hoped, will use fuel more efficiently than it has been used in the past. This stand is also being run in conjunction with National Fuel Efficiency Service, a non-profit making organisation which was set up by the British Productivity Council at the instigation of the Ministry.

Among the models is one of the 1,800-h.p. gas-turbine locomotive for which the North British Locomotive Company, Limited, is building the chassis and C. A. Parsons and Company, Limited, the turbine. It is expected to have a thermal efficiency which is markedly greater than that of the conventional piston-engined steam locomotive and to be capable of completing the Glasgow-London run on about half the normal fuel consumption. Another illustrates an experimental 1,000-kW closed-cycle coal-fired gas turbine which is at present being assembled at the works of John Brown and Company (Clydebank), Limited, to be used for the double purpose of generating electricity and supplying hot water for part of a works heating system.

Electrical energy is being produced on the stand directly from chemical reactions with theoretically higher efficiencies than are possible with conventional power cycles. This is being done with the aid of the device, known as a fuel cell, which we illustrate in Fig. 5. In the cell exhibited hydrogen and oxygen are fed separately to two porous nickel electrodes, between which is circulated a concentrated solution of potassium hydroxide. Direct current is taken from the cell at approximately 0·8 volts and at current densities of above 100 amperes per square foot of electrode.

The storage of electrical energy as well as generation is possible in the hydrogen-oxygen cell which has been developed by Mr. F. T. Bacon, now of the Chemical Engineering Department at Cambridge. This cell is, it is claimed, the most successful fuel cell reported so far, and although at present pure hydrogen – not an economic fuel – is used, it is hoped that the cell may be the forerunner of a true fuel cell. Meanwhile, the possibility of storing electricity as hydrogen and oxygen, produced by electrolysis of water, and using the " Bacon cell " to regain the energy by electro-chemical combustion of these gases offers great promise. The cell operates at 200 deg. C. and 600 lb. per square inch pressure and would supply a certain amount of waste heat at 200 deg. C.

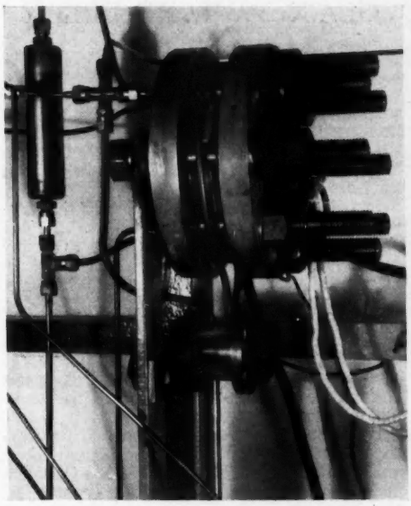

Fig. 5 Using porous nickel electrodes and an electrolyte of potassium hydroxide, this cell generates electricity at current densities of 100 amperes per square foot of electrode.

Two other types of fuel cell are being studied in Britain, one, a high-temperature cell operating at atmospheric pressure, employing industrially available gases such as carbon monoxide at a temperature of 700 to 800 deg. C. The other, a low-temperature cell using a reduction-oxidation system. This latter system involves the separate transfer of the reducing properties of the carbon fuel and the oxidising properties of the air to a chemical " carrier " outside the cell; the interaction of the reducing carrier and oxidising carrier inside the cell then produces electricity.

Until experiments on a larger scale have been completed, it is impossible to be definite about the applications of the hydrogen-oxygen fuel cell, but the most probable are thought to be for rail traction on lines not yet electrified, for road traction in certain instances, in the storage of wind power and for power generation generally.

To be continued

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MOBILE RECTIFIER EQUIPMENT

Booster for Special Occasions, or Stand-by for Stationary Sets

In connection with the extension of the trolley-bus system at Auckland, New Zealand, the Hackbridge and Hewittic Electric Company, Limited, Walton-on-Thames, Surrey, have made seven rectifying equipments, each rated at 675 kW. Six of these are for fixed substations, but the seventh is mounted on a trailer.

The unit forms a complete mobile substation which can be used to boost the supply when abnormal demands occur, as at sports meetings or special exhibitions. It consists of a main oil-filled transformer, a high-voltage oil circuit-breaker, two standard rectifier units and two direct-current feeder panels incorporating the switch and control gear.

In operation, the three-phase 6·6-kV supply cable is connected to an air-spaced terminal box and the outgoing direct current is connected to a suitable feeder pillar for the 550-volt trolley wires. The unit can be left unattended for indefinite periods. When the unit is adjacent to a fixed substation, a multi-core cable can be plugged in to give complete remote control as for the stationary sets.

GLASGOW WIRE FIRM'S CENTENARY

In 1854 William Riddell began business as a wire weaver and wire worker in a modest workshop not far from Glasgow Cross. The business he started was one of the progenitors of Begg, Cousland and Company, Limited, Springburn Wire Works, Glasgow, who have now been in existence for 100 years.

In 1843 Alexander Cousland entered the wire-working trade and established his workshop in premises which the firm was to continue to occupy for 85 years. Another wire worker of those days was Alexander Rowat, whose business, established in 1837, was purchased by Begg, Cousland and Company in 1933. It is from these three businesses that Begg, Cousland and Company, Limited, derives. To celebrate the centenary of the company, 152 business associates and friends were entertained by the directors to luncheon in Glasgow recently.

From their inception all three firms were engaged in wire-working and weaving. Rowat and Cousland developed more on the wire-working side, whereas Riddell concentrated more on weaving, and soon had a dozen or more looms producing Fourdrinier wires for paper mills and wire cloth for a great variety of industrial purposes. With the death of William Riddell in 1876, the business was sold to Robert Hannah Begg in partnership with his son William. The business outgrew the capacity of the works and in 1881 a move was made to the site where the works of Begg, Cousland and Company now stands.

In 1884 the buildings were burnt to the ground, and with them all the plant they contained. Immediate reconstruction and re-equipment were carried out. Towards the end of the century the paper machine wire department was sold, and the company from then onwards concentrated on the "narrow" loom side of the business which served industry generally.

From their early beginning Alexander Cousland and Son and William Riddell and Company developed along almost parallel lines. After the first World War, understanding and friendship between the management of the two firms ripened, culminating in their amalgamation in 1924. In addition to the weaving side, the company also had departments for non-ferrous fine-wire drawing and annealing, wire-brush making, smith work, and plant maintenance. Among contracts of outstanding importance placed with Begg, Cousland and Company were those for wirework on board ships built on the Clyde, such as the Hood, the Vanguard, the Indefatigable, the Queen Mary, the Queen Elizabeth, the Caronia, the Olympia, and the Royal Yacht Britannia.

The business of the firm has expanded steadily over the years, and the staff now number just over 400, which is almost exactly 100 per cent. more than it was 30 years ago. To mark the centenary the employees were entertained by the company to a day's outing on June 11.

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THE SCOPE FOR DIESEL ENGINES

Hague Conference in 1955

Arrangements made by the International Internal-Combustion Engine Congress for holding the third international meeting of the Congress at Scheveningen, the seaside resort of The Hague, are now well advanced. The dates chosen are from Monday, May 23, to Saturday, May 28, 1955, and have been selected as the period when satisfactory accommodation is most likely to be available, and to suit the convenience of persons desiring to attend the Fourth World Petroleum Congress at Rome, which will be held from Monday, June 6, to Wednesday, June 15, next year.

An examination committee has been set up and has decided that papers, to be acceptable for the 1955 Internal-Combustion Engine Congress, must deal either with the existing prospects of Diesel engines for railway traction, or with the possibilities of marine and stationary Diesel engines having a capacity of more than 10,000 h.p. or comprising units of not less than 2,500 h.p. each.

There will be seven working sessions during the congress, which will be known officially as "Colloquy 1955 – The Hague," and it is considered that the number of papers accepted must be limited to 30, to enable sufficient time to be devoted to discussions. Complete texts should be submitted to the committee before the end of September, 1954.

An official dinner will be held at Scheveningen on May 26, and there will be a choice of industrial visits on May 27, but it is not intended to arrange a series of excursions, owing to the proximity of the Whitsun holiday and the Petroleum Congress at Rome.

Programmes will be issued later in the year and, in the meantime, communications may be sent to the British Internal Combustion Engine Research Association, 111-112 Buckingham-avenue, Slough, Buckinghamshire.

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LAYING-OUT TO FULL SCALE

Lithographic Reproduction on Any Surface

Tiltman Langley Laboratories, Limited, Redhill, Surrey, have opened a London office to undertake full-scale layout for the aircraft and other industries. They consider that the system can be applied with advantage to any industry using sheet metal, since from one master layout it is possible to prepare routing templates, bend blocks, drilling and assembly or inspection jigs, as well as records on paper and linen. Complete interchangeability and mating are thereby secured, since all the detail parts are made from the same original layout.

In the Tiltman Langley drawing office, a lithographic method of reproducing the layouts on to a wide variety of surfaces is employed. The initial layout is drawn in cellulose ink on an aluminium plate having a grained surface. Depending on the application, information such as flange developments, flange angles, and other items required in the manufacturing and inspection processes, is included on the drawing. For reproduction, the lines on the layout plate are coated with printers' ink and placed in contact with a gelatine-coated transfer plate. The latter is then placed in contact with the material on which the print is required and pressure is applied. Routing templates, for example, are obtained by printing on to plywood and cutting to the development lines, and drilling jigs are made by printing on to mild-steel sheet and drilling through the marked stations.

The chairman of the company, Mr. A. Hessell Tiltman, and the managing director, Mr. Marcus Langley, have been intimately connected with the adoption of full-scale layout methods by the British aircraft industry. Mr. Tiltman prepared the first complete survey of full-scale layout for the Society of British Aircraft Constructors in 1943, and Mr. Langley was a member of the S.B.A.C. sub-committee which subsequently devised a standardised layout system which has been adopted by the whole British aircraft industry, and which makes it possible for layout plates to be transferred from one establishment to another.

Information on the application of the process may be obtained from the London office manager, Mr. Coates Smith, at 70-71 New Bond-street, London, W.1 (telephone MAYfair 0267).

FRESH PROBLEMS IN AIRCRAFT DESIGN

Air Registration Board's Report

"The most important feature in civil aviation activities during the past year has undoubtedly been the operation of turbine-engined transport aircraft on scheduled passenger services. The commencement of these operations has not been trouble-free and . . . it is clear that . . . all moves towards the adoption of the new or the unorthodox . . . have been accompanied by risks unknown and dangers unseen. I am, however, convinced that we are right to extend ourselves to the utmost to maintain our lead in this field . . ." These are the opening words of the chairman of the Air Registration Board, the Rt. Hon. Lord Brabazon of Tara, in the seventeenth annual report of the Board, for the year ended March 31, 1954.

The Board, it is stated, is continuously facing fresh problems in investigating new and complicated systems arising from the operator's demand for pay load, speed, range, comfort and world-wide use. Among current problems are the introduction of a realistic form of simulated feel in powered control systems; the incidence of fatigue in high-tensile aluminium alloys used in aircraft primary structures; the possible need to stop jet engines in flight to reduce fire risk in a defective engine and to prevent engine breakup; the use of reverse thrust for braking; the need for a suitable form of fuel heating to prevent fuel systems from icing-up at high altitude; and the introduction hydraulic fluid systems which are non-inflammable.

In the international field the Board has been trying to secure the automatic reciprocal validation of certificates of airworthiness, and progress has been made in the United States towards the validation of certificates for turbine-engined aircraft.

ULTRA-LIGHT AIRCRAFT

Discussing power-plant development, Lord Brabazon regrets that no suitable engines for ultra-light aircraft have yet been produced. Development of liquid-cooled piston engines has virtually ceased. Although some development of a large compound piston engine is still proceeding, its future appears to be increasingly obscure. One new medium-power double-row radial engine is under development. A few other piston-engine developments stem from existing types.

Gas-turbine development is proceeding rapidly. The Dart turbo-propeller engine in the Viscount is giving excellent performance, and the Ghost jet in the Comet has shown increasing reliability and life between overhauls.

During the past 12 months, only 50 per cent. of the pilots examined for commercial licences were successful. This is attributed to a lack of basic knowledge of the aircraft type, probably arising from the fact that ex-Royal Air Force pilots had experience mainly on primary trainers and jet aircraft, with virtually no knowledge of commercial aircraft.

Among the activities of the Board discussed in the report may be mentioned the issue of design requirements, including test schedules, for rotorcraft; the flight-testing of a number of prototype aircraft including the Blackburn Universal Freighter and the Bristol Britannia; the preparation of flight manuals and the approval of manufacturers' service and instruction manuals, the quality of which has improved greatly over the past two or three years and which now provide operators with data for preparing maintenance schedules and procedures and training school syllabus.

BOOK REVIEWS

V2. By Major-General WALTER DORNBERGER. Translated from the German by JAMES CLEUGH and GEOFFREY HALLIDAY. *Hurst and Blackett, Limited, Stratford-place, London, W.1.* (16*s.*)

This English translation of the original German book published in 1952 makes fascinating reading. It is essentially a popular book designed for a wide range of readers, and purely technical information is mentioned incidentally as the story is told, and then it is only given in a simple and necessarily superficial manner.

General Dornberger was in charge of the Army's research on rockets from the first stages in 1930 until the end of the war. In this book he tells the story of liquid-propellant rocket missiles, from the early days at Kummersdorf under Army sponsorship, to the final stages of the war, when Peenemunde and the A.4 programme became the centre of political intrigues as the Ministry of Munitions and the Himmler S.S. organisation endeavoured to wrest control from the Army. The early struggles for recognition and financial backing from official quarters make interesting and entertaining reading, and when one remembers the stress laid on his "secret weapons" by Hitler in the latter stages of the war, the difficulties Dornberger was up against in raising the priority of his work, even when Peenemunde had become well established and the performance of A.4 was known, come as a surprise. In particular, Hitler showed little interest in the work of Peenemunde early in the war, and when he did give the A.4 programme top priority it was too late for it to influence the course of the war.

Divergent views have been expressed about the military value of the V.2 rocket. It has been stated that, had the effort put into the V.2 (or A.4 as it was known at Peenemunde) for development and production been used to improve bomber aircraft and fighter defences, it would have been to the military advantage of Germany, certainly in the critical final phases of the war. However, it seems quite certain that had the war continued for another few years, ballistic missiles of the A.4 type, and the various guided weapons developed by the Germans, would have changed the whole pattern of the war.

The A.4 was an outstanding technological development. The liquid propellant unit giving 56,000 lb. thrust for up to 60 seconds was several orders larger than previous liquid rocket motors. As far as the combustion chamber was concerned, the scaling up was achieved by using 18 burners of a design proven on a 1·5-ton thrust chamber. The development of a large turbo-pump unit which had to deliver some 275 lb. per second of propellant at about 350 lb. per square inch pressure and had to develop about 560 h.p., was a most praiseworthy technical achievement.

Equally outstanding was the development of a control system; the A.4 was stabilised in roll, yaw and pitch by an automatic pilot which operated two pairs of control surfaces through an electro-hydraulic servo system. On firing vertically upwards with the pitch axis perpendicular to the plane containing the target, the A.4 missile was slowly rotated in pitch by precessing the pitch gyro in a predetermined manner. The range was determined by shutting off the motor at an appropriate velocity. Initially, this was achieved by determining the velocity on the ground using the Doppler effect, and transmitting a shut-down signal. Eventually, the use of an integrating accelerometer made the missile quite independent of ground control, and eliminated the possibility of enemy radio interference which, although it was never used, had been considered to be the vulnerable aspect of the weapon.

The transfer of a complicated piece of equipment from development to production is rarely unattended by problems. The A.4 had been developed by a brilliant team of scientists anxious to achieve perfection by continuous research and development, and Dornberger gives an interesting account of some of their problems, both political and technical, on moving from experimental production for test firings to mass production for Army firing teams. A single fault of any component in a missile could lead to its complete failure, and a success rate as high as 80 per cent. represented no mean achievement in wartime.

The book is not written in chronological order and the reader may have some difficulty in deciding the exact sequence of events. The frequent use of the first person singular become tiresome at times, though this no doubt is due to the book being essentially personal in character.

The technical reader will regret that fuller details have not been given about the organisation of Peenemunde, the development phases of the A.4, the aerodynamical, control and propulsion problems encountered. Enough is given in Dornberger's book to whet one's appetite; a full technical account of the Peenemunde developments has yet to be published.

The Airport Visitor. Edited by Squadron Leader N. J. FREEMAN and G. D. H. LINTON. *Penman Enterprises, Limited, 202 Cheam Common-road, Worcester Park, Surrey.* (2*s.* 6*d.*)

Primarily intended as a handbook for spectators at British civil airports, the sub-title of this compact paper-covered illustrated booklet claims, justifiably, that it is "The Annual Guide to Commercial Aviation." As in previous years, it presents concise information on the principal airports in the United Kingdom, brief descriptions of the types of airliners, both British and foreign, to be seen at them, and a list of their registration numbers and names. A useful reference feature is the directory of national, foreign and independent airlines giving notes of the type of aircraft they use and the routes over which they operate. In addition, there are several short articles of general interest on various aspects of aviation.

* * *

TRADE PUBLICATIONS

Oil Burner. Kingdom Engineering Co., Ltd., Combustion Engineers, 22 Waterloo-road, Wolverhampton, have sent us a leaflet which gives full details of their oil-proportioning burner. The burner is of simple design. It has a single lever control, gives positive oil atomisation, and is suitable for use with any grade of fuel oil. The air flow is controlled at the nozzle outlet to give constant primary and secondary atomising air pressure at the point where the atomisation of the fuel oil takes place.

Agricultural, Earthmoving and other Tractor Equipment. The "Ferguson System," that is, the application of the Ferguson tractor to the building industry, road making and maintenance, factories, docks, quarries, dams, airfields, forestry and public parks, and the vast range of equipment designed for use with this tractor in these fields of work, is well illustrated in a booklet recently received from Massey-Harris-Ferguson (Sales), Ltd., Coventry.

Liquid-Level Controller. An instrument designed for controlling the level of liquids in tanks and other containers is described in a booklet published by Sunvic Controls, Ltd., 10 Essex-street, Strand, London, W.C.2.

Alternating-Current Motors. Lancashire Dynamo & Crypto, Ltd., St. Stephen's House, Victoria-embankment, London, S.W.1, have issued a list of 400/440-volt 3-phase motors that are in stock. Over 150 types are listed.

Underground Electric Locomotives. The Atelier Constructions Electriques de Charleroi, the London offices of which are at 56 Victoria-street, London, S.W.1, have sent us a brochure describing the various types of electric locomotives they manufacture for use underground, as well as details of the substations and collecting equipment.

Boiler-Feed Equipment. An illustrated booklet issued by G. and J. Weir, Ltd., Cathcart, Glasgow, gives a brief survey of some of the more important factors to be considered when planning the feed system of the modern power station. Examples are given and performance characteristics are illustrated graphically.

BOOKS RECEIVED

Conference on the North Sea Floods of January 31 to February 1, 1953. *The Secretary, The Institution of Civil Engineers, Great George-street, London, S.W.1.* (25*s.*)

The Repair of the Small Electric Motor. By KARL WILKINSON. *E. and F. N. Spon, Limited, 22 Henrietta-street, London, W.C.2.* (20*s.*)

A Bibliography of Colour Television. *The Television Society, 164 Shaftesbury-avenue, London, W.C.2.* (2*s.* 6*d.*)

Laundries and Laundry Requisites, 1954. *Anglo-Scottish Press, Limited, 26 Old Brompton-road, London, S.W.7.* (7*s.* 6*d.*)

Fire Research, 1953. Published for the Department of Scientific and Industrial Research and Fire Offices' Committee by *H.M. Stationery Office, Kingsway, London, W.C.2.* (2*s.* 6*d.*)

The Oscilloscope at Work. By A. HAAS and R. W. HALLOWS. Published for "Wireless World" by *Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1.* (15*s.*)

Hydraulic Systems and Equipment. By R. HADEKEL. *Cambridge University Press, Bentley House, 200 Euston-road, London, N.W.1.* (18*s.*)

Chemical Engineering Materials. By FRANK RUMFORD. *Constable and Company, Limited, 10 Orange-street, London, W.C.2.* (32*s.* 6*d.*)

Laplace Transforms for Electrical Engineers. By B. J. STARKEY. Published for "Wireless Engineer," by *Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1.* (30*s.*)

The African Native Market in the Federation of Rhodesia and Nyasaland. A Report on the Central African Native as a Consumer. Prepared by the United Kingdom Trade Commissioner, Salisbury. *H.M. Stationery Office, Kingsway, London, W.C.2.* (1*s.* 6*d.*)

The Application of Results of Research. Compiled and edited by VERA CONNELL, in collaboration with the British Commonwealth Scientific Offices, London. *Butterworths Scientific Publications, 88 Kingsway, London, W.C.2.* (21*s.*)

Annual Report on the Public Works Department (Nigeria) for the Year 1950-1951. *Crown Agents for the Colonies, 4 Millbank, London, S.W.1.* (9*d.*)

Union of South Africa. Overseas Economic Survey. By the United Kingdom Trade Commissioners in the Union. Published for the Board of Trade, Commercial Relations and Exports Department, by *H.M. Stationery Office, Kingsway, London, W.C.2.* (4*s.* 6*d.*)

The Year's 16 mm. Films, 1953. The Guide Book to Factual and Entertainment Films. *Current Affairs, Limited, "Film User" Office, 174 Brompton-road, London, S.W.3.* (6*s.* 6*d.*)

Optical Instrumentation. By Members of the Staff of the Optics Section, Metallurgical Laboratory, University of Chicago. Edited by GEORGE S. MONK and W. H. MCCORKLE. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (3·75 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (30*s.*)

Induction and Dielectric Heating. By J. WESLEY CABLE. *Reinhold Publishing Corporation, Book Division, 330 West 42nd-street, New York 36, N.Y., U.S.A.*; and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (100*s.*)

Theory and Design of Steam and Gas Turbines. By JOHN F. LEE. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.*; and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (64*s.* 6*d.*)

Electronics. A Textbook for Students in Science and Engineering. By THOMAS BENJAMIN BROWN. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.*; and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (60*s.*)

Engineering Contracts and Specifications. By ROBERT W. ABBETT. Third edition. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.*; and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (48*s.*)

Applied Electronics. A First Course in Electronics, Electron Tubes, and Associated Circuits. By TRUMAN S. GRAY. Second edition. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.*; and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (72*s.*)

La Machine-Outil. Volumes III and VI. By A. R. MÉTRAL. *Dunod, 92 Rue Bonaparte, Paris* (6e). (Volume III, 5,900 francs; Volume VI, 2,500 francs.)

AN EXPERIMENT TO ILLUSTRATE CREEP

USE OF COSTLY EQUIPMENT AVOIDED

By N. S. J. Grassam, B.SC.(ENG.), PH.D., A.M.I.C.E., A.M.I.MECH.E.
and A. Prince, B.MET., A.I.M.*

It is common knowledge and probably has been for some hundred, if not thousand, years that lead sheets and pipes deform slowly but considerably under their own weight.

In 1904, one of the first published papers[1] on what has become known as the creep phenomena dealt with the time-dependent portion of the deformation obtained when metallic lead was stressed. Although Phillips in 1905[2] noted the similarity in the creep behaviour of such diverse materials as india-rubber, glass and metals, the first scientific investigation of the creep phenomenon was undertaken by Andrade[3] using wires of lead and other materials.

The significance of this work was not appreciated for some years but eventually the practical importance of the phenomenon of creep was pointed out by Dickenson[4] in 1922, in a paper which gave the results of the first long-time creep tests. His work and that of the famous French metallurgist Chevenard[5] showed that creep was not the exclusive property of the softer metals but was also an inherent factor in the behaviour of the more usual engineering metals and alloys when stressed at elevated temperatures for long periods. The conclusion, which probably undermined the faith of the practising engineer in his factors of safety, was that a metal would stretch continuously and eventually fracture at a stress below its apparent yield point at the working temperature.

From 1922 to this day, an ever-increasing interest in the subject of creep has been evident among both engineers and metallurgists. A great stimulus was given to its study by developments in steam-turbine practice during the 1920's and later in the development of the gas-turbine and jet engines. The engine designer is always anxious to raise operating temperatures in an effort to achieve better efficiency but, as in many cases, only limited deformation of the components can be tolerated, the metallurgist is called upon to develop increasingly creep-resistant alloys. From the point of view of design it is desirable to select a material capable of operating at as high a stress as possible for a particular temperature. It is unfortunately true, however, that to maintain low creep rates at elevated temperatures requires low stresses. A compromise between temperature and stress is therefore necessary.

The rate of creep of most engineering metals near their maximum operating temperature is relatively sensitive to small variations in stress at a particular temperature, or to small variations in temperature at a particular stress. For this reason components in a material which has a satisfactory creep rate, at a given temperature and stress, may not be satisfactory if either the stress or the temperature is increased by even such a small amount as 10 to 15 per cent.

To demonstrate this point to students of engineering and, at the same time, to illustrate the typical shape of creep curves, the experiment described below has been devised.

A 0·7 per cent. antimonial-lead wire* 12 s.w.g. (0·104 in. diameter) and length approximately 30 in. is used as the test material mainly because it undergoes continuous deformation at room temperature and gives creep strains of up to 30 per cent. Elaborate equipment is not needed; no high-temperature furnace with controlling equipment is required and observations can be made and a family of creep curves obtained in a three-hour laboratory period. The apparatus is shown in Fig. 1. The wire is subjected to a tensile load supplied by lead shot in a container. The shot is added steadily through a funnel and the desired load is reached in about 20 secs. To avoid stress concentrations which would be caused by any form of clamping, the ends of the wire are cast with Cerromatrix into conical adaptors of the type shown in Fig. 2. The wire is tested in the vertical plane and strain measurements are made by noting the extension over a length of about 24 inches. To do this the movement of two paper pointers attached to the wire by thin strips of Cellotape is observed against a fixed metre scale. This was found to be the most satisfactory method of attachment of pointers as any form of spring clamping invariably caused fracture at the clamp. Readings of the pointers are taken at suitable intervals of time throughout the test. With two observers it was found that, at the beginning of a test, readings every 30 secs. were sufficient to trace the behaviour of the metal, whilst, subsequently, readings every minute were quite adequate. A typical set of results is shown in the graphs Fig. 3 and 4.

Despite the apparent crudeness of the measurements it was found that the curves were quite closely reproducible. As is usual at relatively high rates of creep, it was noted that at the fracture the wire was necked and drawn down to almost a point. The form of the creep curves shows the primary and secondary stages to be quite distinct and no violent increase in the creep rate to occur in the tertiary stage. The particular alloy used is known to age-harden if held at room temperature for any length of time. Secondary effects caused by this ageing phenomenon were not found to influence the shape of the family of creep curves providing all the curves were taken in the stipulated 3-hour period.

From an educational standpoint these experiments, which are carried out by second year students of engineering at the University of

* Dr. Grassam and Mr. Prince are at the University of Southampton; Dr. Grassam being lecturer in Mechanical Engineering and Mr. Prince lecturer in Metallurgy.

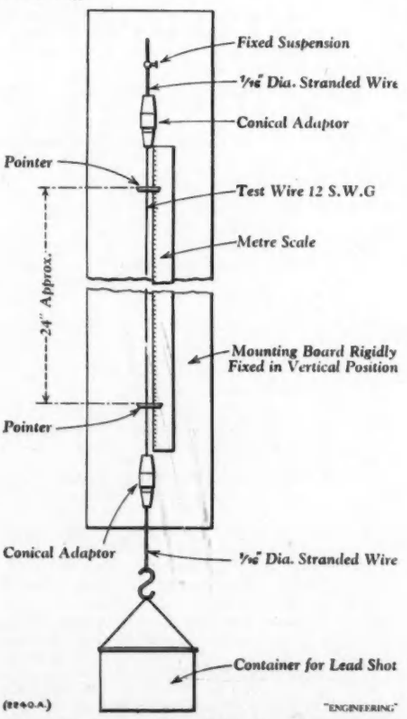

Fig. 1 Using antimonial-lead wire with this simple apparatus gives a simple and quick illustration of creep.

* This material is used for sheathing certain electric cables and was kindly supplied by Messrs. Pirelli-General Cable Works, Limited, Eastleigh.

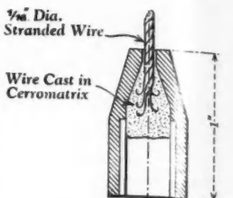

Fig. 2 Conical adaptors permit the test wire to be loaded without giving rise to undesirable stresses.

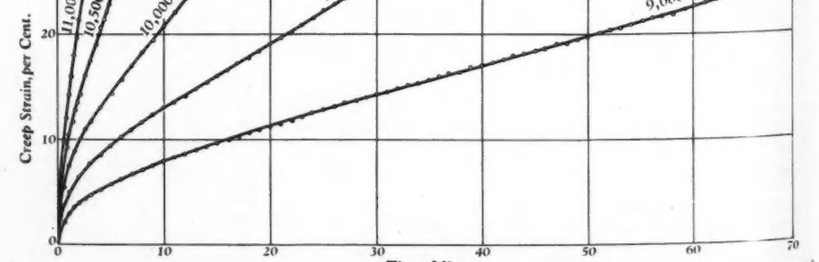

Fig. 3 This family of creep curves for antimonial-lead wire was obtained in three hours.

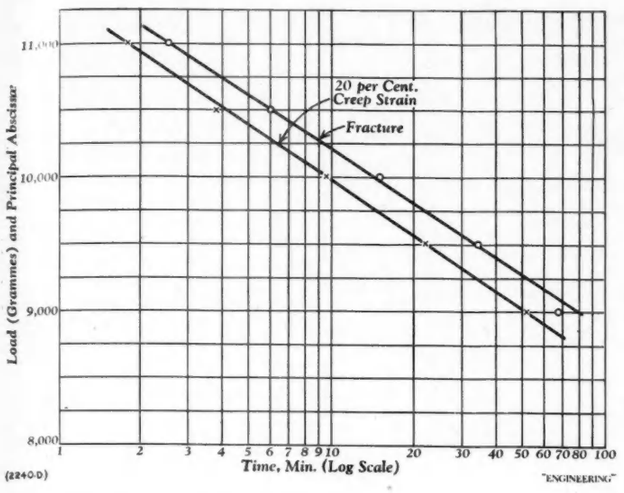

Fig. 4 Load - time curves for antimonial-lead wire. The curves were found to be closely reproducible with the apparatus described.

Southampton, are very useful for in the space of 3 hours it is possible for two students working together to obtain a family of about five creep curves. By this means it is thought that knowledge of a phenomenon which today is essential to all mechanical engineers can be demonstrated in a short space of time without costly and complicated equipment.

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[3] E. N. da C. Andrade, *Proc. Roy Soc.*, A 84, page 1 (1910); A 90, page 329 (1914).
[4] J. H. S. Dickenson, *Jl. I. and S. Inst.*, vol. 106, page 103 (1922).
[5] P. Chevenard, *Comptes Rendus Acad. Sci., Paris*, vol. 69, page 712 (1919).

SEAMLESS STEEL GAS CYLINDERS*

SIGNIFICANCE OF SAFETY FACTOR IN DESIGN

By S. E. Mitchell

Millions of seamless steel gas cylinders are used to store and convey highly compressed oxygen, nitrous oxide, carbon dioxide and various other gases. The designer of a gas cylinder must adopt some value for the working stress, and he is often both guided and limited in his choice by statutory regulations or by a recognised specification. The value will not be the same for all materials of construction, a lower stress, for example, usually being allowed in a mild-steel than in a nickel-chromium-molybdenum-steel cylinder. The specified working stress is derived from a property, such as the tensile strength, determined by mechanical test on samples. The number by which the stress determined under test is divided to obtain the working stress is customarily termed the " safety factor."

The following discussion, based on papers presented to the Home Office Gas Cylinders and Containers Committee (1946) and the British Standards Institution Secretariat Panel (ISO) on Gas Cylinders, outlines the application of the safety factor to the design of seamless steel gas cylinders and suggests a possible unification of the diverse methods now in use. The first part of the article describes these methods and the arguments in their favour; a common basis for deriving the working stress is proposed in the second part.

PRESENT PRACTICES

The design of a gas cylinder is based on limited data bearing a relation to some of the more obvious influences to which it will be subjected in the course of service. Separate allowances are usually made for corrosion and for external loading (for example, due to storing the cylinders in piles). Corrosion is generally allowed for by an extra thickness added to that required for other purposes, and external loading by limiting the minimum thickness.

Apart from these allowances, the wall thickness is calculated from a permissible stress figure. Some designers maintain that this stress should be set at a given fraction of the yield stress of the material used; others, that the stress calculated at the hydraulic test pressure (equal to some given multiple of the maximum working pressure) should not exceed a certain value; and yet others, that the stress should be set at a given fraction of the tensile strength of the material used.

A safety factor represents an attempt to allow in terms of a practical testing technique for a very large number of unpredictable variations in service conditions. Besides simple stress, these may include small deformations; various combinations of stress and strain; impacts; vibration and temperature changes which may cause fluctuations of stress; manufacturing variations in dimensions; and, perhaps, varying degrees of misuse depending upon the intelligence and scrupulousness of the user. No single property determined by mechanical test is an infallible index of the behaviour of the cylinder in service. It is not imagined, because the calculated working stress in the wall of a cylinder is required not to exceed, say, one-third of the tensile strength, that service conditions will be liable at the worst to induce a stress of three times the calculated working stress, and to make no other demands on the cylinder. The test which is to serve as the basis for applying a factor of safety should therefore be the one that is the best index of the general resistant qualities of the material.

Gas cylinders can be divided into two classes. The first class comprises cylinders for permanent and high-pressure liquefiable gases; these are nearly always employed at a comparatively high internal pressure, and normally the wall thickness needed to resist this pressure will make the cylinder stout enough for all ordinary loading and handling. The second class comprises cylinders for low-pressure liquefiable gases. For these, the resistance to external loads and handling acquires greater relative importance; and the making of cylinders which are very thin in relation to their diameter may be impracticable. The necessary wall-thickness is governed by these factors rather than by the internal pressure.

STRESS CRITERIA

A constant factor of safety applied to the yield stress finds favour in some quarters. By this method very light cylinders can be designed in alloy steels and light alloys, treated to raise the yield stress to a high value. The yield stress may, indeed, be very close to the tensile strength. The term " yield stress " is used loosely, and in materials that do not show the yield phenomenon of mild steel it denotes a proof stress corresponding to 0·2 per cent., or some other small percentage, of permanent strain.

Materials with a high proof stress may, however, save little or no weight in cylinders for low-pressure liquefiable gases, where, as explained above, the minimum practicable thickness depends largely on rigidity and manufacturing limitations.

When cylinders are designed to a stress calculated at the hydraulic test pressure, and when this pressure is a simple multiple of the working pressure, there is no difference in principle from designing to the stress at the working pressure. The factor of safety is still applied to the yield (or proof) stress, or to the tensile strength.

The hydraulic-test pressure is, however, not always made a simple multiple of the working pressure. A value of one-and-a-half or two times the working pressure does not provide a very searching test on cylinders for low-pressure liquefiable gases, and the stringency of the test varies with the working pressure and with the diameter of the cylinder. For this reason a hydraulic-test pressure is often advocated which will induce in the wall of the cylinder a stress not far short of the yield stress. This test pressure is calculated on the designed wall thickness of the cylinder, and the test is carried out as a stretch test – that is, the permanent expansion of the cylinder is observed. Excessive permanent expansion indicates some deficiency, such as insufficient wall thickness, in the cylinder.

Where the hydraulic test pressure is chosen in this way to give a stress approaching the yield stress and not directly related to the stress at the normal working pressure, it is not usually employed as a design factor – probably because internal pressure of any kind is not, in this case, of primary importance in design.

For cylinders for permanent and high-pressure liquefiable gases the hydraulic test pressure can be expressed as a multiple of the working pressure and still, in actual fact, induce a stress in the cylinder wall approaching the yield stress of the material. Here, if the design formula includes the stress at the test pressure, the yield stress is the implied criterion.

In cylinders made from materials of high yield strength, the pressure required to apply a stress approaching the yield may be beyond the range of commonly available apparatus, and a lower test pressure is sometimes adopted as a matter of expediency. In such circumstances, even if the design formula included the stress at the test pressure, the factor of safety would not necessarily be applied to the yield stress. The test pressure would be, in effect, arbitrarily

* Communication from the Mechanical Engineering Research Laboratory. The work described was carried out in the Mechanics and Materials Division of the Mechanical Engineering Research Laboratory as part of the research programme of the Mechanical Engineering Research Board, and it is published by permission of the Director of the Laboratory.

chosen, and by the inclusion of a suitable multiplying factor in the design formula the working stress could be related to either the yield stress or the tensile strength.

A factor of safety applied to the tensile strength is regarded by its advocates as the best practical means of relating the design of the cylinder to the general resistant qualities of the material used. It is true that a material might have a very high tensile strength and yet be very brittle, but common-sense precautions, such as the stipulation of a minimum elongation in the tensile test, are assumed.

In view of this, the factor of safety applied to the proof (or yield) stress in a material in which this proof stress is close to the tensile strength is regarded as somewhat artificial; for the factor of safety on the tensile strength is in that case very little more than the factor of safety on the proof stress, whereas in mild steel it may be nearly twice the factor of capacity on the yield stress. Moreover, an increased proof stress in any material may be accompanied by a decreased impact resistance. Experience has also shown that, with alloy steels and light alloys, an increased proof stress is not necessarily accompanied by an increased fatigue resistance, and therefore does not always justify a higher working stress.

PROPOSALS FOR A COMMON BASIS OF DESIGN

The values of the working stress in the design of gas cylinders differ to some extent in different countries and for different materials of construction. The present discussion assumes the following formula for the calculation of wall thickness:

$t = \frac{pd}{2s - p}$, with a minimum thickness of $0{\cdot}027\,d$,

where t = minimum wall thickness at any point;
p = internal working pressure;
d = inside diameter of cylinder; and
s = maximum permissible stress in cylinder wall at working pressure.

It is proposed that for seamless steel gas cylinders the value of s in this formula shall be some given fraction of the tensile strength of the steel. The ratio of the working stress to the tensile strength is in the neighbourhood of one-third in many specifications; in other words, the safety factor on the tensile strength is approximately three.

A working stress of one-third of the minimum of the range of tensile strengths specified for steel used is now proposed as a normal maximum in seamless gas cylinders. For certain steels, however, a higher ratio of working stress to tensile strength might be permissible if it were shown by experience to be justified.

Apart from special modifications to cover external loading, the formulæ at present in use for relating internal pressure to stress in the wall are of two main types. One is fundamentally the same as that given above, though the minimum-thickness requirement may differ. The other, prescribed in the American and Canadian regulations, is:

$$S_p = \frac{P(1{\cdot}3D^2 + 0{\cdot}4d^2)}{D^2 - d^2}$$

where P = internal pressure;
S_p = stress in cylinder wall at pressure P;
D = outside diameter of cylinder; and
d = inside diameter of cylinder.

This formula is based on the now discredited maximum principal-strain criterion of elastic failure; S_p is not an actual stress, but is the tensile stress which, acting alone, would give the same maximum principal strain as that in a cylinder of the given dimensions under the given pressure. The ratio $\frac{s}{S_p}$ depends on the ratio of thickness to diameter; it is equal to 1·17 when the ratio of thickness to diameter is negligible, and decreases as this ratio increases, becoming, for instance, 1·04 when the ratio of the wall thickness to the diameter equals $\frac{1}{10}$.

The following Table* shows the working stresses permitted in various countries. The stress has been expressed in terms of the tensile strength (T.S.) of the material of construction.

If a stress at the design pressure of one-third of the tensile strength were adopted in cylinders for certain high-pressure liquefiable gases, some of the present test pressures would require modification to avoid producing a stress above, or too closely approaching, the minimum stipulated yield point in some steels.

For cylinders for low-pressure liquefiable gases, where a design pressure not greater than 500 lb. per square inch can be adopted, the over-ruling minimum requirement (t not less than $0{\cdot}027\sqrt{d}$) will operate for all values of d which are practical for seamless cylinders, that is, for values of d not greater than 12 in. If a fixed test pressure is specified for any given liquefiable gas, as it is in several countries, the stress at the test pressure varies with d, and, under certain conditions, might exceed the minimum yield of the material. The graph below illustrates. Horizontal lines representing possible minimum yield stresses of 15, 20 and 26 tons per square inch are drawn to cut the oblique lines which give the stress at any test pressure up to 1,500 lb. per square inch in cylinders of various internal diameters. As an example, the test pressure for a hydrogen-sulphide cylinder, according to the Swiss regulations, is 54 atmospheres (790 lb. per square inch); the stress produced would exceed 15 tons per square inch in a cylinder of 6 in. internal diameter, and 20 tons per sq. in. in a 10 in. cylinder.

A uniform value of not more than one-third for the ratio of working stress to tensile strength could therefore only apply to cylinders for liquefiable gases if test pressures were calculated, according to the material and dimensions of cylinders, to produce some prescribed stress.

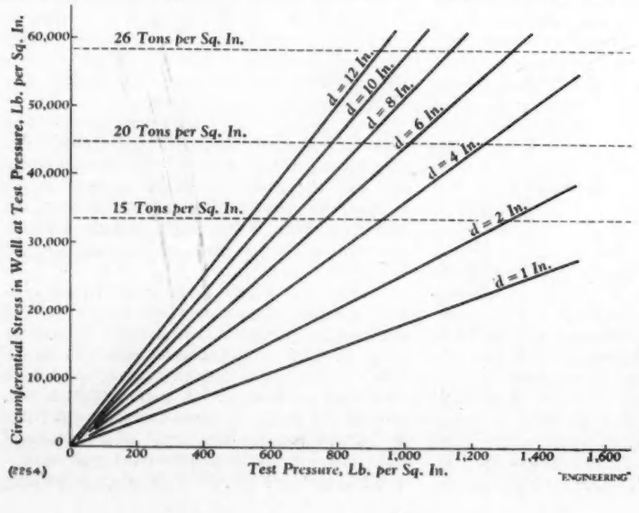
TABLE.—*Working Stress Permitted in Various Countries in Seamless Steel Cylinders for Permanent Gases*

Country	Steel	Maximum allowable Working stress / Tensile strength
United States and Canada: Working pressure up to 900 lb. per sq. in.	Specification 3A and 3AA	$\frac{S_p}{T.S.} = \frac{14,000}{T.S.}$ in lb. per sq. in. ($\frac{s}{T.S.}$ = a higher value – see text*)
United States and Canada: Working pressure over 900 lb. per sq. in.	Specification 3AA	$\frac{S_p}{T.S.} = 0{\cdot}4$, but max. $S = 42{,}000$ per sq. in. ($\frac{s}{T.S.}$ and corresponding over-ruling maximum are higher – see text†)
France	All normally permitted varieties	0·33
Belgium	Carbon	0·3 to 0·375
	Alloy	0·45
Switzerland (internal traffic)	Carbon	0·325
	Alloy	0·4
Switzerland (international traffic)	Carbon	0·29
	Alloy	0·36
Germany	All normally permitted varieties	0·31
South Africa ..	Low carbon ..	0·37
	High carbon ..	0·265
	Manganese ..	0·41
	Alloy	0·42
Great Britain ..	B.S. 400 (low carbon)	0·32
	B.S. 399 (high carbon)	0·30
	B.S. 1045 (manganese)	0·34

* The highest value of $\frac{s}{T.S.}$ in practice would probably be 0·38, when $\frac{s}{S_p} = 1{\cdot}17$ and tensile strength = 44,800 lb. per sq. in. (20 tons per sq. in.).

† The highest value of $\frac{s}{T.S.}$ in practice would be 0·47, when $\frac{s}{S_p} = 1{\cdot}17$; but s cannot exceed 49,100 per sq. in. (22 tons per sq. in.).

* The values in the Table are based on information collected by F. S. Marsh and C. Twigg of the Chesterfield Tube Company, Limited. S_p denotes the working stress, calculated by putting $P = p$, and not the stress at the test pressure specified in the American and Canadian regulations.



Graph showing the wall stress in gas cylinders of various diameters when containing gas at various pressures.

★ ★ ★

ASBESTOS-BITUMEN ROOFING MATERIAL

Easily Worked and Suitable for Flashing

A demonstration of the way Nuralite, a new roofing material, can be worked and formed to practically any shape within a few minutes by one man with the aid of a blow lamp, a knife, and a few simple formers was given recently in London. The material is made from bitumen and asbestos in about equal proportions, and is suitable for use in place of metal for flashings, weatherings and all roof fittings.

A sample of this material, which is being marketed by Nuralite Sales, Limited, 3-4 Whitehall-place, Gravesend, Kent, was tested by the Joint Fire Research Organisation, Elstree, who state in a report that it offers a greater degree of protection than roofing felts conforming to B.S. 747: 1952.

A NEW DESIGN OF INFRA-RED SPECTROMETER

Diffraction Grating used for Dispersion

In recent years, infra-red spectrometry has found many applications in science and industry for the analysis or control of compounds having absorption bands in the infra-red part of the spectrum. Such compounds occur in various industries, notably petroleum refining, the production of lubricating oils, the manufacture of plastics, paints, detergents, explosives, drugs and many other substances. In these industries infra-red spectrometers are used for laboratory work and for the control of the products. The instruments, however, as usually constructed, are costly due, to some extent, to the fact that the dispersion is effected by prisms of rock salt, fluorite or some other material transparent to infra-red rays of long wavelength to which glass is more or less opaque.

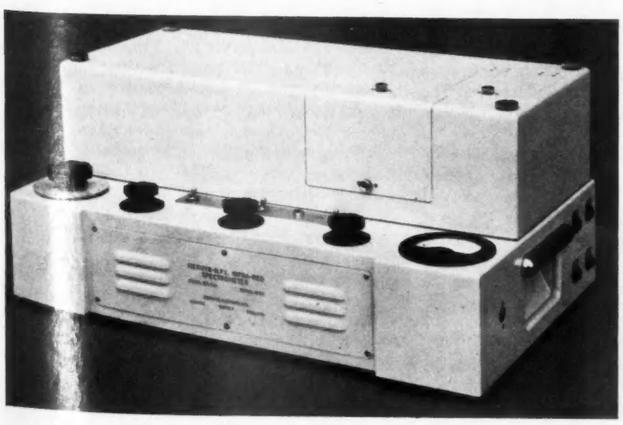
In the new infra-red spectrometer now being constructed by Mervyn Instruments, Copse-road, St. John's, Woking, Surrey, which they have developed in collaboration with the National Physical Laboratory, a diffraction grating is used for dispersion instead of optical prisms and as the gratings are produced by a method due to Sir Thomas Merton, F.R.S., and developed at the Laboratory, an efficient spectrometer can be produced at a considerably lower cost than was formerly the case. We described the process of making the gratings on page 714 of our 171st volume (1951), but we may now give the following brief explanation of the process as a reminder. A very fine screw thread is cut on a highly-finished metal cylinder by means of a precision lathe and this thread is used as a leading screw for cutting a second thread on the same cylinder, the cutting tool being traversed by a nut made of a soft resilient material such as cork. The special nut has the effect of eliminating any periodic errors in the first screw so that the second screw is nearly perfect. The grating is made by coating the latter with a plastic material, which when dry is stripped off, bearing on it the impression of the thread in the form of a series of closely-spaced parallel lines; in this case there are 8,000 lines per inch. When mounted the plastic material forms an excellent diffraction grating.

The source of radiation in the spectrometer is a Nernst "glower" the emission from which extends well into the infra-red. The radiation is passed through the substance to be examined, which may be either solid, liquid or gaseous, then through a slit on to a mirror which directs it on to the grating. A lever attached to the mounting of the grating bears on the edge of a cam which is turned continuously by a synchronous motor. The shape of the cam is such that as it rotates the grating is tilted backwards and forwards through a small angle so that a part of the spectrum covering the wavelength range from 2·8 μ to 3·8 μ is reflected from the grating on to a second mirror, a filter being provided to absorb the spectra of unwanted orders produced by the grating. It may be mentioned that the mechanical arrangements are such that the grating is turned slowly in one direction but flies back almost instantaneously to its original position. The spectrum is reflected by the second mirror on to a photo-electric cell of the lead-selenide type which is highly sensitive to infra-red radiation and the output from the cell is amplified and supplied to a combined indicating and recording instrument both parts of which are graduated to read the percentage transmission. Thus a "valley" corresponding to each of the absorption bands appears on the record.

SPECIAL DESIGN FEATURES

The above is an abbreviated and simplified description of the instrument to enable its general arrangement to be followed. There are, however, several other points in the design which should be mentioned. For instance, the light from the Nernst filament is interrupted 800 times per second so that an alternating current is supplied to the amplifier, which is of the high-gain type, and is followed by a special correlation detector. An adjustable integrator network is provided combining adequate sensitivity with control of the signal/noise ratio at the output. The very high order of stability necessary for quantitative measurement is obtained by a special system of compensation developed by the makers. By this system the light output from the Nernst filament is continuously monitored through the detector and the gain of the amplifier is adjusted automatically so that variations in the output from the source, the sensitivity of the detector or drifts in the amplifier characteristics produce negligible variations in the output. Another novel feature is the provision of a continuously adjustable cam by which the gain level of the amplifier is automatically corrected to allow for the wavelength characteristics of the source, the filter and the detector. This feature obviates the need for applying a correction to the record which has usually to be obtained in single-beam spectrometers by running through the spectrum without a sample in position and plotting from the resultant curve.

The external appearance of the instrument is shown in the accompanying illustration; the chassis is of cast aluminium and is sealed so that it can be evacuated or filled with a gas if required. This spectrometer, we understand, will be shown at the First International Instrument Congress and Exposition to be held under the auspices of the Instrument Society of America, in Philadelphia, from September 13 to 24.



By using a diffraction grating instead of an optical prism the cost of this infra-red spectrometer is kept low.

* * *

TESTING LAMP BULBS

National Coal Board Set Up Station for Quality Control

The National Coal Board have set up a testing station at Treorchy, South Wales, to check the quality of bulbs supplied to them for use in miners' lamps throughout the coalfields. These bulbs, an essential factor in the production of coal, are relatively expensive when it is realised that the Board buys some 2½ million a year at a cost of about £200,000. A form of quality control has, therefore, been introduced with a view to maintaining the high standard of lighting essential for production and the health of the miner.

The objects of the station are to accumulate basic information about all types of miners' lamp bulbs produced by the different manufacturers, to establish routine testing, and to seek the co-operation of suppliers in achieving and maintaining a consistent quality. The testing of new types of bulbs is also undertaken before production quantities are made. A large proportion of miners' lamp bulbs are manufactured to British Standard No. 535 : 1953, and all testing procedure at the station conforms strictly to this specification. The specified tests fall into three main categories: physical, photometric, and life.

In the physical tests, bulbs are examined for overall size, for mechanical strength in a torsion testing machine, and for light-centre length. In the main, conventional apparatus is employed, but the station uses a projection apparatus for measuring light-centre length in which a magnified image of the bulb under test is thrown on a calibrated screen. This is an important test because the light distribution from the reflector of the miners' cap lamp is dependent upon the light-centre length of the bulb.

The photometric apparatus was designed to meet the special requirements of the station with regard to accuracy, speed, and ease of operation. A method of substitution photometry is employed and standard bulbs calibrated by the National Physical Laboratory at Teddington are used for setting up and checking the equipment. The photometric apparatus accommodates ten similar bulbs at one time, placed at regular intervals on the perimeter of a turntable rotated by an electric motor controlled by means of a foot switch. Each bulb is brought round in turn, raised by push-button control to the centre of a sphere, the appropriate voltage is applied, and the current and light output measurements are made.

The life-testing equipment was designed by the Board's engineers and scientists and was assembled in their own workshops. Precautions have been taken to provide a voltage constant within limits which are even narrower than those specified by the Standard. In the life tests, bulbs are measured for their current consumption and light output at their rated voltage, first at 40 per cent. and later at 60 per cent. of their specified life. The life of a bulb as used in the pits should, it is considered, be from 2½ to 3 times its life under laboratory test conditions for the reason that, using battery supply, the bulbs are underrun for quite a large part of every working shift. The manufacturers of miners' lamps serving the industry visit the station and co-operate freely in the interchange of information and the checking of samples.

TESTING PNEUMATIC AND VACUUM COMPONENTS

UNIVERSAL MACHINE TO SIMULATE WORKING CONDITIONS

Shown in the accompanying illustrations is the prototype of a universal test rig for pneumatic and vacuum equipment fitted to military aircraft. The rig has been designed and constructed, to a Ministry of Supply order, for the Royal Air Force by the Hymatic Engineering Company, Limited, Redditch, Worcestershire. It provides for testing any current type of aircraft compressor, vacuum pump, valve, ram, and other pneumatic component in service with the Royal Air Force, and for simulating conditions encountered in flight.

The rig is housed in a fabricated steel-frame cabinet with readily detachable steel covers. The instrument panels may also be removed easily to ensure safety in transit and to facilitate maintenance. Below the instrument panels, which have fluorescent strip lighting, is a bench equipped with two driving heads, a vice, and an immersion tank with flush-fitting lids. Mounted on castors for mobility, the cabinet when finally installed is raised on four integral jacks to provide a steady and level base.

At the left-hand side of the cabinet is a ram-testing fixture, in which pneumatic rams undergoing dynamic tests are mounted by shackles between two vertical members of steel channel pierced to allow the shackle anchorages to be adjusted to suit the ram-pin centres. The load is absorbed by a hydraulic slave ram bolted to the upper ends of the frame. Operation of the pneumatic ram causes oil to be expelled from the slave cylinder through a bleed valve into a tank which supplies oil to the other side of the slave ram. The speed of stroke may be varied by adjusting the bleed valve. The hydraulic load is indicated on a gauge.

A system of non-return valves makes the performance of this test independent of the direction of stroke. The slave ram has a piston rod on each side of the piston to equalise its effective areas. In each direction the ram can be stopped at any point of the stroke for measuring the static thrust and for leakage tests. A steel-yard attached to the same structure is usually employed in testing spring-loaded rams, which are mounted above it if they have spring extension and below if spring retraction.

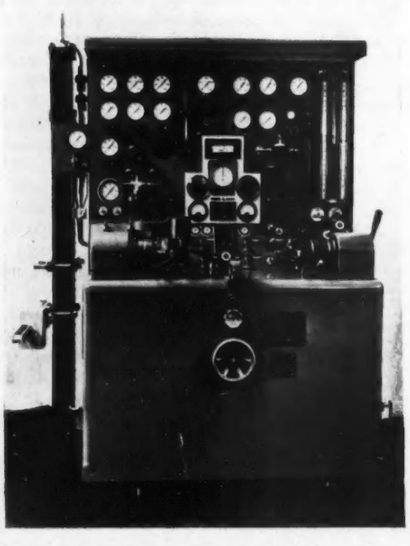


Fig. 1 Hymatic universal test rig for aircraft high-pressure compressors and pneumatic components (left-hand drive head and instrument panel), vacuum pumps and low-pressure rotary compressors (right-hand drive head and instrument panel). The fixture on the left is for static and dynamic tests on pneumatic rams.

The rig is divided essentially into two main sections – high-pressure compressors and pneumatic components being tested on the left-hand side, and low-pressure rotary vane-type compressors and vacuum pumps on the right-hand side. Also on the right is a hydraulic circuit for pressure-testing vessels and components under pressures up to twice their normal working value; this circuit consists simply of a hydraulic oil reservoir housed in the body of the rig, a handpump and non-return valve, two outlet connections with stop valves, and a return valve to the tank which must be closed in order to allow pressure to be built up in the system.

VARIABLE-SPEED DRIVE

A three-phase 440-volt electrical supply and a supply of water for the lubricating-oil cooling tank are required. Both the driving heads are driven by a 7½-h.p. constant-speed motor in the lower part of the rig. The drive is taken through a gearbox (designed by F.U. (London), Ltd.) of continuously-variable speed ratio from unity to 10-to-1, and then to a belt-driven countershaft, from which belt drives are taken through two hydraulically-operated friction clutches to the left and right driving heads respectively.

The speed ranges are, respectively, 250 to 2,500 r.p.m. (for high-pressure compressors), and 400 to 4,000 r.p.m. (for vacuum pumps and low-pressure compressors); the variable speed gear is controlled from the handwheel on the lower part of the cabinet. The starter push-button for the driving-head motor is mounted on a switch panel together with indicator lights and the starter switches for two motors driving a lubricating-oil pump and a fan which supplies cooling air to high-pressure compressors.

For supplying direct current for operating a torquemeter, or alternatively for testing electro-pneumatic valves, a motor generator set is mounted vertically at the left-hand side of the rig. This can be seen on the right lower part of Fig. 2; this illustration also shows a controllable air inlet for compressor cooling, a precipitator tank and outlet connection for the oil-laden air exhausted from vacuum pumps, and the storage tank for the lubricating oil, which contains a 500-watt thermostatically-controlled heater. The main drive countershaft, which is supported on three bearings, can also be seen.

Both driving heads have interchangeable driving quills to suit the different shafts in components under test, and will accept standard types of mounting flange. The clutch for the left-hand driving head is hydraulically coupled to the lubricating oil circuit so that it cannot be engaged unless there is adequate oil pressure in the pipe lines feeding the high-pressure compressor.

DYNAMOMETER-TYPE DRIVE HEAD

The left-hand driving head is of the conventional type whereas the right-hand head is arranged to enable torque measurements to be carried out when testing the low-pressure rotary compressors. The bearing housing comprises a floating flange, from the underside of which protrudes an encastered arm, restrained at its outer end between simple spring-loaded supports. Torque applied to the flange deflects the arm and this deflection is transmitted through electrical resistance strain gauges, connected in a Wheatstone bridge circuit, to a direct-current microammeter calibrated in lb.-ft.

Fig. 2 Rear view of test rig with covers removed.

The bridge is balanced by a rheostat, and the applied voltage is similarly adjusted to the value at which the system is calibrated. A single voltmeter is used for indicating both generator output and bridge voltage. The system is calibrated by applying a known torque, by means of an arm and weight bolted to the floating flange and setting the voltage so that the microammeter needle indicates the correct torque reading on the appropriate scale. This microammeter can alternatively be switched to record the output of a thermocouple detecting the delivery air temperature of a compressor under test.

HIGH-PRESSURE PNEUMATIC CIRCUITS

The high-pressure pneumatic section of the rig comprises the main " bottle " circuit which includes the main 400-cub. in. air storage bottle, and three subsidiary circuits – the " receiver " circuit, the " line " circuit, and the " brake " circuit, which are used in conjunction with the bottle circuit for various types of test. For measuring air leakages down to 0·08 cub. ft. per minute a Rotameter flow meter is provided.

The bottle circuit is used alone for tests in which the compressor is called upon to charge a vessel of fixed capacity in a specified time. For this purpose, three alternative pressure gauges (on the extreme top left) are connected with the bottle, for pressure ranges from zero to 600 lb. per square inch, 1,600 lb. per square inch, and 3,000 lb. per square inch respectively. The first two can be isolated when the higher pressures are in operation. The bottle is provided with an outlet connection and a stop valve, the latter being closed for charging; a controllable bleed valve in parallel with the output connection enables the effects of varying altitude to be simulated.

The receiver circuit, which incorporates a 20 cub. in. receiver, is used mainly for testing electro-pneumatic valves. The receiver, which is provided with a discharge valve, is connected to two outlet unions through a stop valve, one

of these outlets being further controlled by a bleed valve; it is thus possible to carry out functioning tests with, or without, the 20 cub. in. volume in the line, or to provide a controlled pressure build-up. Two alternative pressure gauges for ranges of 0 to 600 lb. and 0 to 1,600 lb. per square inch are provided.

The line circuit, used in conjunction with the bottle circuit, provides for testing compressors, regulators and other components under simulated aircraft-system conditions. On the front face of the left-hand instrument panel are two regulator connections, to which the regulator appropriate to the compressor concerned is connected. In the line circuit, the compressor delivery passes through an oil and water trap, then through pressure gauges (0–1,600 lb. and 0-3,000 lb. per square inch), where it divides, through stop valves, to the regulator inlet and to an outlet connection, the latter also being controlled by a bleed valve to simulate altitude conditions. The output of the regulator is connected to the large storage vessel in the bottle circuit, which represents the aircraft receiver-vessel.

The brake circuit serves solely for testing the brake-differential valves which provide direction control, through the rudder bar, when the aircraft is taxying. It is arranged to simulate the layout of an aircraft pneumatic-brake system.

VACUUM AND LOW-PRESSURE AIR CIRCUITS

On the right-hand side of the rig, mercury manometers indicate the suction and outlet pressures of vacuum pumps and the suction pressure of rotary compressors under test. In the case of vacuum pumps, to simulate the resistance offered by the aircraft instruments and circuits, a coiled 20-ft. tube can be connected between the suction inlet of the pump and the calibrated suction orifice. The exhaust of the pump (the temperature of which is recorded on a gauge beside the manometer) can be directed either through a small aircraft-type oil separator, again to simulate operating conditions, or through the large precipitator tank, from whence it is ducted to atmosphere.

Lubricating oil for the vacuum pump can either be supplied directly by the oil system which also serves the high-pressure pneumatic circuit and clutch-operating rams, or, to check the oil consumption, a calibrated oil bottle on the instrument panel can be pre-charged by the oil pump and can then be fed to the vacuum pump, over a specified period of time, by air pressure from the bottle circuit on the left-hand side of the rig.

The lubricating arrangement for low-pressure rotary compressors is of the air-pressure displacement type; the oil supply is contained in a reservoir and circulated through a watercooled tank (the temperature of which can be regulated). The compressor delivery is led to the reservoir, thus providing a pressurised supply for the compressor bearings. As already described, provision is made for measuring the torque of rotary compressors; other measurements include the pressure at a calibrated outlet orifice, the air delivery pressure and temperature, and the oil supply temperature.

PRODUCTION OF SMALL PRECISION CASTINGS

THE INVESTMENT OR "LOST WAX" PROCESS

It is only in recent years that the ancient "lost wax" process has been adapted for the production of precision castings for engineering and scientific purposes. Under its new name "investment casting" – the word "investment" is used in the military sense of surrounding the wax patterns completely with the material forming the mould – the process is now used for producing a wide range of small precision castings in a variety of metals and alloys. The dimensional accuracy and surface finish of the castings are of a very high standard, and in addition the process makes possible the production of components of complex form which would be difficult, or even impossible, to manufacture by any other method. Dimensional accuracy and surface finish are of obvious importance in reducing machining costs, and are essential where the material from which the casting is made is difficult to machine. These qualities are indispensable when alloys which cannot be machined at all by normal methods are being cast.

In a previous issue (ENGINEERING, April 9, 1954, page 455) reference was made to the work being done in the investment-casting field by Deritend Precision Castings, Limited, Bays Meadow Works, Vines-lane, Droitwich Spa, Worcestershire. At that time the company had only recently started production at the Droitwich works, which were built because the original Birmingham works were too small and expansion there was impossible. Bays Meadow Works, which are now in full production, cover 17,000 square feet and employ over 100 workpeople.

The works are engaged on the production of investment castings ranging in size from a fraction of an ounce to several pounds, and with normal dimensional limits of ± 0·005 in. Under certain conditions even closer tolerance can be achieved. The materials cast include mild and medium-carbon steels, medium-carbon alloy steels, heat- and wear-resisting and other stainless steels, case hardening steels, nitriding steels, and tool steels of many specifications. Other materials include the cobalt-chromium alloy Stellite, Nimonic, and beryllium copper. Any alloy, in fact, which can be cast at all is suitable for the investment process. The castings are homogeneous in structure, and are completely free from directional properties such as are found in forgings and rolled material. Alloys which are normally machinable in the wrought form possess the same properties in this respect when produced by the investment process.

DIE MAKING

The expendable wax patterns are produced, as is shown in Fig. 1, in injection moulding machines, and the first stage in the production of investment castings is therefore the manufacture of an accurate master pattern from which suitable dies can be made. The master pattern, which is of brass, mild steel, or duralumin, is suitably oversized to allow for wax and casting shrinkage. From this pattern, dies of the single- or multiple-impression type, according to the shape and size of the casting, are made. Three methods of die making are used: die sinking from the solid in the conventional way, fabrication, and casting. The first of these methods requires no description. It is slow and expensive, and is not used to any great extent. The second method, building up the die from a number of components, not necessarily of the same material, is particularly applicable to long runs and is frequently used. The third method, casting the die, is quick and relatively cheap, and since it is as accurate as the master pattern itself, it is the most common method of producing dies made at Bays Meadow Works. For casting dies, a tin-bismuth alloy, similar to type metal, is used. This alloy has a good surface, and since it neither expands nor contracts on cooling, it is ideal for the purpose. The die is, of course, made in two halves, and after extraction of the master pattern it is fitted with dowels, ejector pins, and backing plates as required for mounting in the moulding press. The accuracy of the dies, by whichever method they are made, is of great importance since the wax is injected at high pressure while it is plastic, and any imperfection in the dies would be reproduced in the wax patterns, and so in the finished castings.

The patterns are moulded in a wax which cools rapidly, and they can be removed immediately the dies are parted. Suitable ejector pins, operated by a small hand lever, are fitted where necessary to simplify the removal of the pattern after moulding. The wax patterns, moulded either individually or in groups according to size and shape, are next mounted on runners or "riser bars," which are also of wax but of a

Fig. 1 Moulding expendable wax patterns at the Droitwich Spa works of Deritend Precision Castings Ltd.

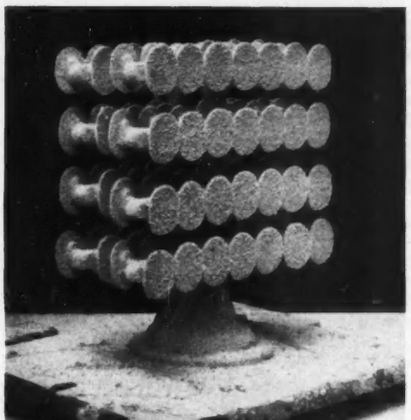


Fig. 2 Two typical wax assemblies, coated with ceramic material and coarse refractory, ready for "investment."

Fig. 3 The mould has been clamped to the furnace, and the latter has been inverted, to pour the metal into the mould.

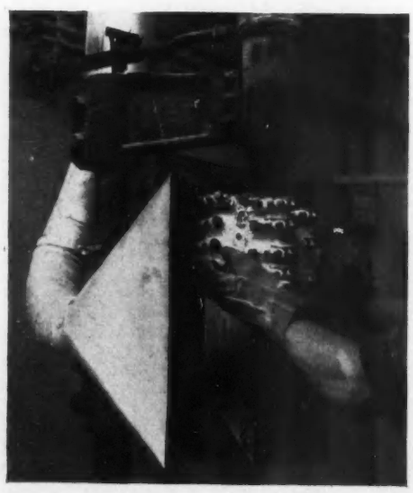


Fig. 4 Vibrating the casting assembly to break away the refractory material

softer and more flexible nature. This work is done by hand, the operators being provided with electrically heated tools, or "irons," with which they soften a small area of the riser bar and press each pattern into position. The riser bars are in turn mounted, in the same manner, on a larger runner to form a complete assembly, which is the basis of the mould. This large runner is then mounted on a base plate; an example of a mounted runner is depicted in Fig. 2.

REFRACTORY COATING

The completed wax assemblies are then sprayed, by means of a hand-held spray gun, with a thin coating of highly-refractory ceramic material in very finely divided form. This constitutes the mould facing with which the molten metal will come in contact, and being of smooth texture ensures a good surface finish on the casting. The facing material is then sprayed with a backing of coarser refractory to bond with the refractory material which will form the main body of the mould.

A metal container, tapered to enable it to be withdrawn easily at a later stage, is then placed over the base plate, and locked to it with two bolts and nuts. A slurry, consisting of a high-grade refractory material and a bonding agent, usually tetra-ethyl-silicate, is meanwhile prepared in a small machine of the concrete-mixer type, and this slurry is then poured into the container until the wax assembly is completely covered. This is the "investment" from which the process takes its name. The filled containers are then placed on vibrating tables and vibrated to ensure good packing of the refractory material round the wax assembly. This vibration is continued until the material is quite hard; surplus liquid is then poured away. Drying in a gas-fired oven follows, during which the tetra-ethyl-silicate hydrolises with the free water present in the slurry, and a sticky silica-gel is deposited all round the refractory particles, bonding them together. The mould is then solid and self-supporting, and the container and base plate are stripped away and sent back to the investment section for re-use.

WAX REMOVAL AND MOULD FIRING

The mould is now complete, and it only remains to remove the wax patterns, which have fulfilled their purpose of producing suitably-shaped cavities. The moulds are therefore placed in gas-fired ovens and the temperature is raised until the wax melts and runs out of the cavities. The wax is recoverable, but it is only used for making riser bars. Most, but not necessarily all, of the wax is removed at this stage. The moulds are then fired in an oxidising atmosphere, at a temperature of 1,100 deg. C. This firing serves the double purpose of burning out any wax which may have been trapped in wells in the mould cavities, and raising the mould to a temperature suitable for casting. It is, of course, important that the wax be removed completely, and for this reason a wax is used which will burn away without leaving any trace of ash. It is equally important that the moulds should be at an elevated temperature when the metal is poured into them. The casting of thin sections would otherwise be impossible due to the chilling effect as the molten metal entered a cool mould.

The furnace used for the firing process is of the continuous type, fired on town gas. Moulds are placed on cars which are drawn mechanically along a rail track extending the length of the furnace; the arrangement is similar to that commonly used in the ceramic industries. A track is provided at the side of the furnace, complete with traversers at each end for returning the cars to the charging end after they have passed through the furnace and been unloaded. The moulds when they leave this furnace are ready for casting, but a gas-fired holding furnace is provided to store hot moulds in case metal is not immediately available.

MELTING AND CASTING

The metal is melted in small electric induction furnaces, which make it possible to control temperature, atmosphere, and speed of melting very closely. Only sufficient metal to fill one mould is charged at each melt. The induction furnaces are trunnion-mounted, and are arranged so that they can be inverted for pouring purposes. When the metal is molten, a hot mould is placed on top of the furnace crucible, and clamped in position by a simple screw clamp; this part of the operation is illustrated in Fig. 3. The furnace is then rotated manually through 180 deg., and the metal enters and fills the mould. The cast mould is then placed in a mechanised cooling tunnel, where it is allowed to cool for several hours. When cool the refractory material is broken open and the casting assembly is exposed. The final stage in removing the refractory material from the casting assembly is carried out on the pneumatic knock-out shown in Fig. 4. This machine, which is controlled by a pedal, clamps the assembly in position and vibrates it until the majority of the refractory material is shaken off. Any small quantity which may still adhere to the surfaces of the castings is removed when the finished castings are shot blasted.

TRIMMING AND FINISHING

The casting assemblies pass from the knock-out to the trimming section, where they are first cut up into convenient pieces by a flexible abrasive wheel. Then, as in Fig. 5, the castings are separated from the riser bars or feeders by means of a high-speed friction band-saw, and they are then ready for final finishing. They are shot blasted to remove the last traces of refractory material, and then have the ends of the feeders removed by hand grinding. Heat treatment as required follows, and the castings pass on for final inspection. This includes X-ray examination, crack-detection, pressure testing, and testing for mechanical properties, as required by the particular customer's specification. There is also a close check of all castings for dimensional accuracy. A final light shot blasting is given to the castings and they are then ready for dispatch.

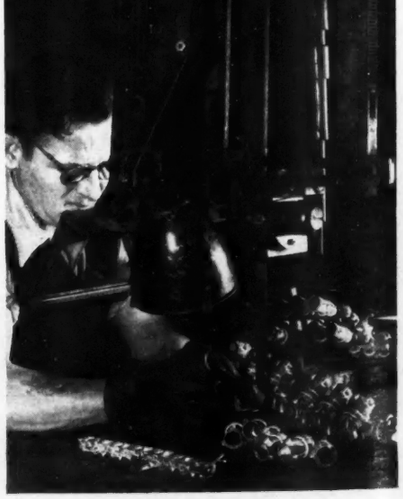


Fig. 5 Removing the risers or feeders with a friction band-saw.

DRAWING COPPER TUBES

HIGH-SPEED MACHINE FOR PRODUCING LONG CONTINUOUS LENGTHS

A demonstration of the drawing of copper tubes was given recently by the Marshall Richards Machine Company, Limited, at their works at Crook, Co. Durham. The machine used was their model H.66.T, a horizontal bull block machine. The tube to be drawn was supplied by Imperial Chemical Industries Limited, who also lent operators skilled in the work. During the demonstration a length of copper tube of 1·35 in. outside diameter and 0·058 in. wall thickness was reduced to 0·375 in. outside diameter with a 0·036-in. wall in six passes.

This type of machine is normally installed in a pit, but in Fig. 1 is shown as set up at the works. The platform represents the floor level of a final installation, and the controls are suitably arranged for this. When fitted with a 150-h.p. motor the die pull that can be exerted is 22,000 lb. at a drawing speed of 200 ft. per minute. These are the maximum design figures for the machine. The coiling drum, or block, has a diameter of 54 in. and a working length of 32 in. The normal drive to the machine is by a direct-current motor supplied either from a grid-controlled rectifier or a motor-generator set. To increase the range of speeds still further, a change-speed gear box, hand operated, is placed immediately after the motor. The drive to the block is through worm reduction gears.

The block is mounted on a cast steel column designed to take the maximum drawing load (which at starting occurs at the free end) without imposing a bending moment on the driving shaft. The latter is splined to the block, which runs on ball bearings. The dogs which grip the tube for pulling it through the die are attached to the block by a length of heavy duty chain, as may be seen in Fig. 2. The edge of the block is shaped to receive the chain and the dogs, and a clip holds the latter to the block as soon as drawing begins. Three sets of dogs are used according to the size of the tube being drawn. Alternatively, the chain can be replaced by a semi-rigid steel blade, balanced to ease the handling of the dogs, but this necessitates a special positioning device to stop the block at the right point to enable the dogs to be connected.

SELF-ALIGNING DIES

The dies are carried in a box which is free to swivel either vertically or horizontally so that the die can align itself during the drawing operation. Provision is made for easy removal of the die in the event of a tube breaking while being drawn. The die box is arranged to take two dies in series; the function of the first is to act as a guide and steady for the tube before it passes into the drawing die. Usually the die from the last pass is used for this and this imposes just enough load on the tube to meet the requirements. The use of two dies is particularly beneficial when tube is being drawn using a floating plug. Standard holders are for dies 4 in. in diameter and 2 in. thick.

The die box and the table, or swift, which carries the coils of tube before drawing, are arranged for power traverse in both directions. A hand-operated gear box gives a range of 14 traverses varying from 0·25 to 1·50 in. per revolution for use with the varying tube sizes. Limit switches stop the machine when the end of travel has been reached. Return can either be by hand or under power. On the swift are a series of horizontal rollers arranged with their axes radial and a set of rollers which can be erected vertically (under pneumatic power) to act as internal guides for the coil of tube. The vertical rollers are used mainly when the drawing speed becomes high and enable the maximum speed to be used with each size of tube. They can be seen erected in Fig. 1.

When the tube has been drawn and is wound on the block, a pneumatically-operated pusher ring can be used to strip it off. The coils can be collected by some form of handling device either for returning for the next draw or for delivery to store. The minimum air pressure required for operation is 80 lb. per square inch. There is provision for shearing the end of the tube hydraulically, and the shears are mounted on the die box. An external supply of oil at about 2,500 lb. per square inch is required.

SMOOTH SPEED CONTROL

The machine used at the demonstration was driven by a 60-h.p. motor supplied from a grid-controlled mercury rectifier. A single lever in a gate frame gave speed control for both forward and reverse running. The range of speeds was controlled by an additional variable resistance in the circuit as well as the change-speed box. Acceleration was smooth, allowing an easy start to the draw; this is an advantage, as the majority of tube breakages occur at the beginning. When a breakage did occur, the block came quickly to rest, even when full drawing speed had been reached. As the drawing proceeded, speed was increased from 150 ft. per minute when the tube was 1·35 in. in diameter to 1,350 ft. per minute for the final reduction to 0·375 in. The original coil of tube was 147 ft. long and weighed 133 lb., and the final length was 867 ft. A floating plug with a face angle 4 deg. different from that of the die was used, being held in place at the start of each draw by the swaged end of the tube in front and a raised bump behind. The tube was generously lubricated externally, but not internally after the first application; a special Cyldol lubricant was used.

This type of machine enables great lengths of continuous tube to be produced very quickly. As the tube is reduced in diameter, so the speed of drawing can be increased. Indeed, the time taken for each reduction remains fairly constant. At the higher speeds, guides and guards became necessary, but there was very little overrun of the drum when the emergency controls were used following a tube breakage. The machine can conveniently be embodied in a conveyor system for handling the tube, and it is in this way that the greatest productions have been achieved in practice. The main pit has to be 11 ft. long by 10 ft. wide by approximately 3 ft. 9 in. deep. The driving motor and gear box increase the length by another 7 ft., but are only about half the width of the main machine. The height from floor level to the top of the guard plate is 6 ft. 9 in.

Fig. 1 Tube can be drawn on this machine at speeds up to 1,350 ft. per min. Normally it would be installed in a pit and the platform here represents floor level. All movements are power operated.

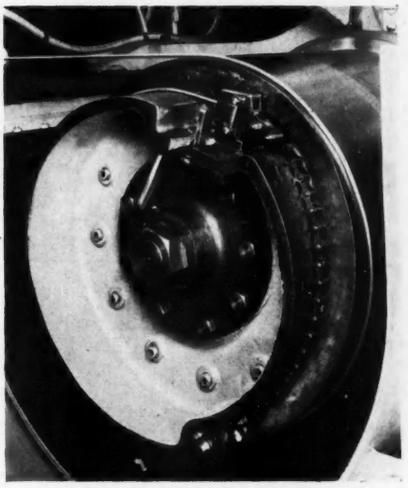


Fig. 2 The chain holding the gripping dogs lies in a shaped lead at the end of the block. Alternatively, a semi-flexible steel blade can be used. The dogs are held to the block by a clip during the drawing operation.

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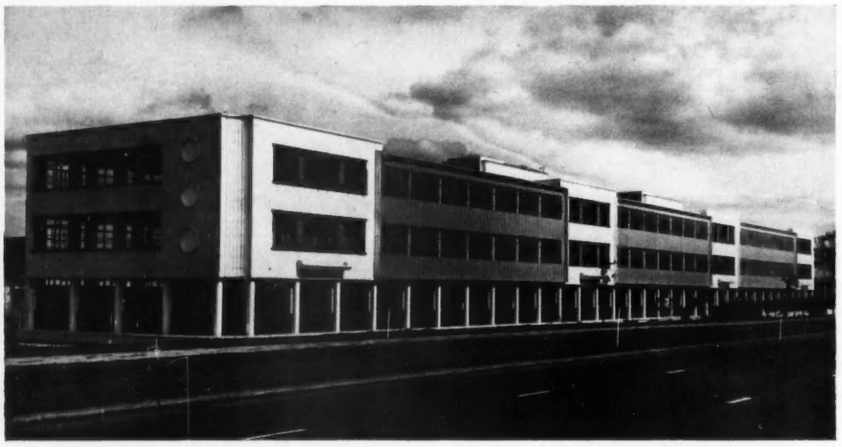
SPRING BALANCES CALIBRATED IN NEWTONS

In 1950, the International Electrical Technical Commission adopted a new unit of force, the Newton, which has since been recommended by the Institution of Electrical Engineers for use in universities and technical colleges. To meet the needs of these institutions, Geo. Salter and Company, Limited, West Bromwich, Staffordshire, have introduced two modifications of one of their standard spring balances. Both the balances have 6-in. diameter dials, with 200 divisions. One has a capacity of 0 – 20 Newtons by 0·10 lb., while the capacity of the other is 0 – 50 Newtons by ¼ lb. (A Newton: a unit of force in the M.K.S. system; the force which causes 1 kg. to accelerate at 1 m. per sec. per sec.)



The new steel-framed de Havilland office block as seen from the Great North-road.

ADMINISTRATION AND DESIGN OFFICE BLOCK

EXTENSIVE USE OF PREFABRICATED UNITS

Shown in the accompanying illustrations is a new building for the de Havilland Aircraft Company, Limited, at Hatfield, designed to accommodate under one roof members of their design staff and administration personnel.

Preliminary sketch plans for the steel-frame building, covering 78,000 sq. ft. within the main walls, were prepared in May last year and the building is now ready for occupation.

The major contributing factors to this achievement were the detailed planning and organisation, and the close co-operation between the four main parties concerned: the de Havilland Company; the architects and services consultants, James M. Monro and Son, 6 Spring-gardens, London, S.W.1; the quantity surveyors, A. L. Currie and Brown, 68 Victoria-street, London, S.W.1; and the building contractors, Bovis Limited, 1 Stanhope-gate, London, W.1.

Site operations were mechanised and full use made of conveyor belts, mono-rails, powered barrows, light cranes, etc.

Excavations for the basements commenced on August 4, 1953. In the south basement, work had to be stopped since, on account of the extremely variable nature of the glacial detritus to be found over this area, bottomless sand was unexpectedly encountered. A system of beam foundations overcame this difficulty.

Erection of the steelwork commenced on November 1, and by the middle of the month Truscon precast floor units, specially designed for the building, began to arrive on site. By the end of that month all steelwork to the first stage was completed.

The steel frame was complete by January 2, 1954, and two weeks later all the floor slabs had been laid and roofing had commenced. The roof units consist of asbestos decking, insulating material, weathering felt, and asbestos solar tiles. Six weeks later the roof was watertight. The work of finishing ceiling panels and wood-block flooring began in March and was completed in stages by early June.

FUTURE EXTENSIONS

The building, designed to harmonise with the existing administration headquarters, has provision for extension in the form of four wings. All necessary lavatory accommodation, service mains and plant rooms have been incorporated at this stage.

At the rear elevation Fural cladding provides a wind and weatherproof covering, easily dismantled and 100 per cent. re-useable to facilitate future extension. The steel emergency stairs on this elevation are also designed for re-use by building into the ends of the future wings.

The main approaches are situated at the rear of the building in order to allow easy circulation to the existing experimental shops.

The lavatories and staircases have been grouped into service towers at the point of junction with the future wings. This conveniently occupies the least well-lit areas, and artificial lighting and ventilation is used throughout except for natural top-light to the staircases. The towers contain vertical service ducts from the calorifier and switch-gear rooms in the basement up to the tank and ventilation-plant rooms at roof level.

The plant rooms house automatic equipment for the supply of temperate air to the building. The service rooms in the basements are kept entirely separate from the main basement areas by fire-resisting walls and have separate approaches from a door to the open quadrangle. Automatic fire-resisting shutters are incorporated in the ductwork, as are also sections giving acoustical absorption. The remainder of the basement is designed for use as document and plan storage and is approached separately from the entrance foyer.

To provide maximum flexibility of utilisation within the main walls, coupled with good daylighting and some degree of acoustical absorption, the building is designed on a 2-ft. module, with stanchions spaced at 14-ft. centres. Beams spanning the entire width are 46 ft. long and fixed to the stanchions with specially stiffened connections. This has made possible an internal layout of four 10-ft. drawing benches with a 5-ft. central corridor, the uninterrupted internal floor area of each drawing office being some 22,000 sq. ft. Three such offices are provided at ground, first and second floors.

Expansion joints on the 473-ft. long building are designed without duplication of stanchions and permit relative movement at three places.

CEILING PANEL HEATING

Radiant ceiling panels are used for general heating, which also give the required acoustical properties. Some 14,000 2-ft. by 2-ft. Menzel removable plaster panels are fixed to a light metal grid containing the heating coils, with glass quilting positioned above to act as an insulating membrane and as an acoustical absorbent; it is continued vertically as a vapour barrier to the external walls. It is believed to be the first installation of its type in the United Kingdom. Small coloured pegs are attached to appropriate panels to denote the services concealed above.

Ventilation is on the plenum principle with a balanced and filtered supply of temperate air and variable rates of flow and extraction, with the main distribution ducts placed outside the main stanchions at the breast wall and beneath the floor to avoid increase in the overall height of the building and its stairs. Fresh air to the top floor is provided by roof ducts mounted between continuous roof-lights. All secondary distribution ducts are so arranged in the ceilings that outlets can be moved with the minimum of disturbance.

The main high-tension transformers are in the basement and local distribution is by way of wall and ceiling ducts. The wall ducts at bench height contain in three sections the lighting and power points, and the internal and external telephone points. From plug points in the ceiling duct above the suspended ceiling flexible leads are taken to the lighting points, the position of which can be varied without alteration to the main wiring. Specially-designed fittings using internally silvered 300-watt tungsten-element bulbs produce indirect general lighting of about 15 ft.-candles service intensity. In addition, separate drawing-board lamps will be used.

For speedy construction prefabricated external cladding and steel staircases were adopted; the latter offered immediate service to the contractor and proved to be a considerable time-saving factor.

The first floor, which is typical also of the ground and second floors. Menzel ceiling radiant-heating panels are employed throughout. Lighting is by 300-watt tungsten lamps.

A NEW RANGE OF AIR COMPRESSORS

RE-DESIGNED CYLINDERS, AIR VALVES AND INTERCOOLER

The air compressor illustrated in the accompanying picture, which has a capacity of 2,000 cubic feet of air per minute, is one of a series now being produced by Belliss and Morcom, Limited, Ledsam-street Works, Birmingham, 16. The series, which is available in capacities ranging from 500 to 10,000 cub. ft. per minute at 80 to 120 lb. per square inch, is based on a crankcase and lower assembly of orthodox pattern, with re-designed cylinders, air valves and intercooler. These components have been re-designed to improve the operating efficiency of the compressor, and to provide maximum accessibility for maintenance purposes. The new type of cylinder and air valve are also applied to single-stage units, with working pressures up to 35 lb. per square inch. The results of full-scale trials are represented in the accompanying graph.

The crankcase and bedplate are of cast iron, the latter forming a lubricating oil sump from which oil is drawn by an integrally-mounted pump and circulated to all the bearings and the crosshead slippers. Oil is delivered under pressure to the crankshaft bearings, thence by holes drilled in the crankshaft to the crankpins, and finally to the crossheads. A mechanical sight-feed lubricator provides lubricant for the cylinders and the metallic packings on the piston rods. The crankshaft is of forged mild steel, with a solid-forged coupling. It is carried in tin-base white-metal bearings bonded to adjustable steel shells, which are designed to accommodate not only the normal radial loads but also any thrust loads which may be imposed by a particular type of drive. The bedplate is flat-bottomed and only a simple foundation is required.

UNIFLOW AIR-STREAM

The cylinder is cast in one piece, with valve pockets in the cylinder barrel. The valves are arranged vertically, the inlet and discharge valves being on opposite sides, with short air passages which are designed to give a streamline air flow. The arrangement of the valves and the fact that the air passages are entirely separate, ensures that the movement of the air through the cylinder is always in one direction, and cool air entering the cylinder is not pre-heated by contact with warm valves and air passages. This uniflow arrangement of air distribution is an important factor in ensuring minimum pressure loss. The layout of the valves also simplifies the design of the cylinder covers, which have no air passages, and permits complete isolation of the cooling water, thus obviating the possibility of water leaks. The box-type pistons, which are fitted with " Rowan " rings, are also of a completely new pattern, and are without core plugs.

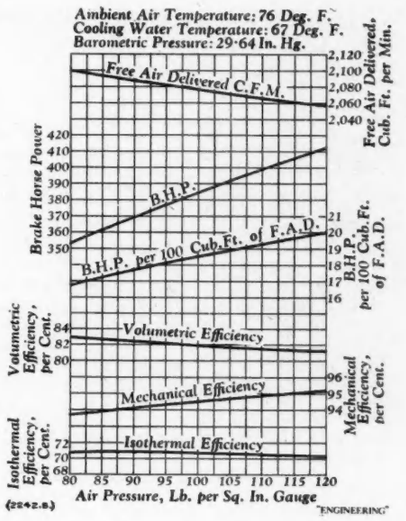
EASILY DETACHABLE VALVES

The valves, which are of the spring-cushion, frictionless type, have been designed for quick access, and to have the greatest possible through area for a given valve size. Being of the frictionless type, they are not subject to the wear experienced with guided valves. They are arranged for easy dismantling and assembly to facilitate cleaning, the components being held together with a single bolt passing through the centre. The complete valve assembly is fixed in the cylinder by clamping the periphery of the valve seat. Possible seat distortion is thus avoided. Access covers, retained by six hexagon nuts, are provided; a complete valve can be removed in about three minutes and replaced in the same time.

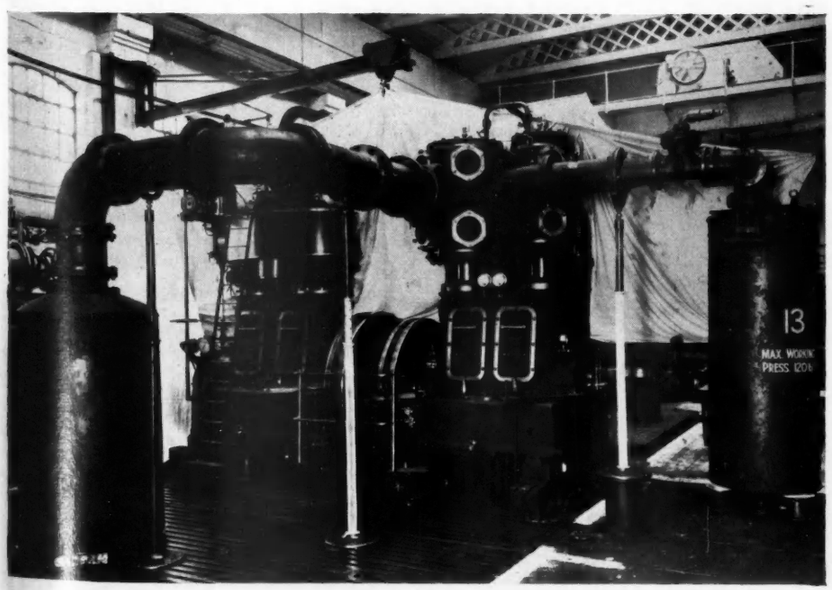
MULTI-STAGE INTERCOOLER

Cooling of the air between the two compression stages is achieved by an intercooler of new design. It has a smaller tube surface area than the pattern previously used, but gives improved heat transfer, the air leaving the interooler being within about 10 deg. F. of the temperature of the cooling water. The intercooler is arranged with removable tube stacks, to which access can be gained by removing the air inlet and discharge pipes. Spare tube stacks can be kept in reserve if required, and the change-over is a simple matter. The intercooler is designed on the contra-flow principle, with a single air pass, which is split up by baffles, and six or more water passes. The tube stacks can be of copper or any other suitable material, according to the nature of the cooling water. Similar tube stacks can be used in an aftercooler if required.

The compressor is fitted with an unloader, which operates a pneumatic valve in the air intake, closing it when the demand for air falls and the receiver pressure builds up. Alternatively, the unloader can be arranged to vary the speed of the drive. It can, for example, operate a hydraulic relay, which controls the speed of a steam or oil engine in accordance with the demand for air.


Ambient Air Temperature: 76 Deg. F.
Cooling Water Temperature: 67 Deg. F.
Barometric Pressure: 29·64 In. Hg.
Free Air Delivered C.F.M.
B.H.P.
B.H.P. per 100 Cub. Ft. of F.A.D.
Volumetric Efficiency
Mechanical Efficiency
Isothermal Efficiency
Brake Horse Power
Free Air Delivered, Cub. Ft. per Min.
B.H.P. per 100 Cub. Ft. of F.A.D.
Volumetric Efficiency, per Cent.
Mechanical Efficiency, per Cent.
Isothermal Efficiency, per Cent.
Air Pressure, Lb. per Sq. In. Gauge
"ENGINEERING"

These curves show the test results obtained on the compressor described in the accompanying article.



A 2,000-cub. ft. two-stage air compressor under test at the maker's works. It is being driven, for test purposes, by a steam engine.

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DROP-STAMP BELTS OF NYLON

Long Life Reduces Overall Costs

The use of nylon drop-stamp belting, which is being increasingly used to replace hair belts in many British drop forges, is stated by British Nylon Spinners Limited, 25 Upper Brook-street, London, W.1, to increase operating efficiency and to reduce costs considerably.

An accurate comparison of the initial cost of nylon and hair belts is not easily made since frequently a smaller nylon belt is employed, but in general the nylon belt probably costs more in the first place. It can be expected, however, to last about three times as long as a hair belt, and this, in conjunction with the time saved by less frequent replacements, is likely to offset the higher initial cost, it is claimed.

A particular example cited is the case of a hair belt which had to be changed every six to eight months. This was replaced by a nylon belt in August, 1952, which is still in use. In the same firm, hair head-straps, which used to last three or four days, have been replaced by nylon head-straps with a life of three or four months, and in this case the first cost of the nylon head-straps is considerably lower.

The strongest nylon yarn is used for drop-stamp belting, with an ultimate tensile strength of 7 grams per denier and an elongation of 15 to 19 per cent. The abrasion resistance of nylon, it is claimed, is greater than that of any other fibre. To fit the belts, metal clamping plates, belts and outboard clamps can be used. The latter are preferable because they avoid the necessity of making holes in the fabric.

CHECKING THE METERS ON AIRCRAFT FUELLING VEHICLES

Mobile Test Vehicle

To ensure that the large fuelling vehicles used at airports for delivering fuel to airliners, at rates of up to 200 gallons per minute per pump, are metering the supplies accurately, Shell-Mex and B.P. Limited, Shell-Mex House, Strand, London, W.C.2, have recently acquired a number of specially-designed mobile meter "prover" units.

The prototype prover unit produced to a Shell-Mex and B.P. design by Sant Sturgess, Limited, Lancelot-road, Wembley, Middlesex, is based on a 20-25 cwt. Bedford A2C chassis. Extensions to the cab-back form a fire screen, and there is a forward exhaust system with an outlet flame trap.

Mounted vertically on the chassis is an elliptical tank, 6 ft. by 4 ft. 2 in. in size, with dished and flanged ends. The upper end is provided with a 13-in. inside-diameter neck about 12½ in. long, terminating in an anti-splash bowl and provided with a central 4-in. diameter internal fill pipe, all protected when not in use by a detachable domed cover. The lower end dish is formed with an offtake pipe leading to a Brookes and Walker three-way control cock, connecting the tank either to a gravity-offtake point or to a Varley DHT.100 pump for powered return delivery when desired.

The tank-top neck is provided with a sight-gauge glass with a nearby scale suitably calibrated and the proving vessel is provided with longitudinal and transverse spirit-level gauges and with two bent-tube type thermometers.

Auxiliary fittings include a Martin Harper power take-off driving the Varley pump through a two-jointed Hardy Spicer shaft, three levelling jacks permanently attached to the chassis frame, an automatic-rewinding cable-reel for static earthing, a micro-filter, and an auxiliary measure and fittings box at the rear of the vehicle.

In service the prover tank is first levelled near the fuelling vehicle to be checked, and the static earthing connection is established; the delivery hose from the fueller is then attached to the prover. If the fueller has a trigger-type nozzle for open deliveries through an over-wing filter cap, the delivery nozzle is inserted into the 4-in. pipe at the top of the prover after removing the domed top cover. If the fueller has underwing wet-coupling integral connections the hose is coupled to a piping point leading to the three-way cock for direct feed to the prover tank.

After a preliminary "wetting" and priming run, metered 300-gallon lots of fuel are pumped into the prover and circulated back to the fueller through the micro-filter. The extent of errors, if any, is determined after correcting the readings to 62 deg. F. for both the vessel and the fluid involved. The meter calibration is re-set by the mechanic in charge of the prover, the meter then being resealed.

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AUTOMATIC APPROACH EQUIPMENT FOR AIRCRAFT

All of the Convair 340 aircraft operated by K.L.M. Royal Dutch Airline have been equipped with special instruments by means of which approaches can be made automatically in bad visibility, and by the middle of July it will be possible to put the system into general use. K.L.M., it is claimed, will thus be the first European airline to make regular automatic approaches. Hitherto the approach and the descent have had to be carried out manually, a procedure which calls for very quick reaction on the part of the pilot, especially in bad visibility conditions. The Sperry "Approach Coupler" fitted in K.L.M.'s new Convair liners feeds signals from the radio beacon directly to the automatic pilot, with the result that the pilot has a controlling rather than an executive function during the approach.

PORTABLE MARINE RADIO TRANSMITTER AND RECEIVER

DESIGNED TO FLOAT ON THE SEA

A portable radio transmitter and receiver for use in ship's lifeboats is being produced by the Marconi International Marine Communication Company, Limited, Marconi House, Chelmsford Essex. It has been named the Salvita and is shown in the illustration below. The complete set is housed in a water-tight container and is designed to float after having been thrown into the sea.

The new set is the result of work commenced in 1931, when a portable transmitter for use in small boats such as the dories – vessels used in line-fishing on the Newfoundland banks where fog often hid them from their parent craft – was designed by the Marconi Marine Company. A further advance in the design of this type of equipment was made during the last war following the issue of a specification by the Ministry of Transport for lifeboat radio equipment for merchant ships. Initially spark transmitters were made for this purpose. They were followed later by valve transmitters and large numbers of both types were produced and distributed for use on various vessels of the British and Allied Merchant Navies.

TEST IN ARDUOUS CONDITIONS

The model now introduced meets the requirements of the G.P.O. specification for this type of equipment and it has been exposed to tests designed to simulate the worst conditions likely to be encountered at sea. One test model was operated while being continuously shaken on a special vibrating table. Then followed a bump test during which it was subjected to 500 jolting bumps at the rate of one per second with a free drop of one inch. It still operated satisfactorily after this treatment.

The next test to which it was subjected was under dry-heat conditions and consisted of 10 hours in a temperature of 70 deg. C. followed by two hours of continuous working at 55 deg. C. A test in damp heat of 40 deg. C. with a relative humidity of 95 per cent. followed. After 11½ hours in this atmosphere the set was wiped dry of condensation and operated for a further half hour under the same conditions. Then it was tested at a temperature of minus 25 deg. C., followed by exposure to high-pressure water spraying for two hours, and finally completely immersed in water for one hour. Tests for corrosion after salt-water spraying, and for mould-growth after treatment with an aqueous solution of mould spores and subsequent incubation, have also been carried out.

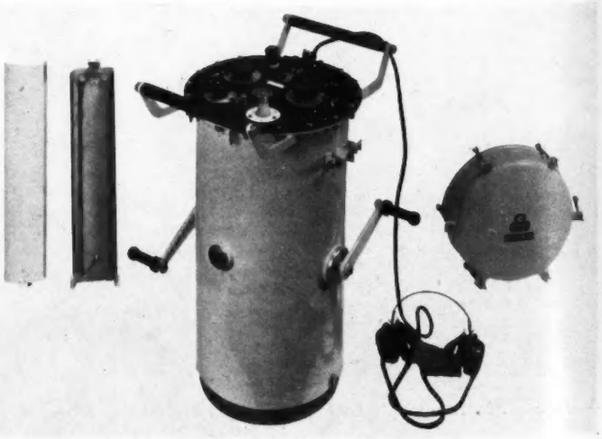
To ensure that the set could be dropped from the deck of a ship without suffering damage it was thrown from a height of 30 ft. into water and operated at full efficiency after it had surfaced and been recovered.

HAND GENERATOR

The housing, as shown in the illustration, consists of a cylindrical case a little over 2 ft. in height painted bright yellow for recognition purposes. Stout carrying handles are fitted and these are also used to carry lashings for holding the set steady when in operation. The upper portion of the case contains a medium-wave and short-wave transmitter and medium-wave receiver. All the operating controls are placed on the circular top panel and covered by a watertight lid when not in use. Batteries have been dispensed with, all the power for transmission and reception being supplied by a hand generator which occupies the lower portion of the case. The generator shaft protrudes through water-tight glands and is rotated by two handles, which fold flat against the case and are protected by detachable covers. In use these covers serve as sinkers for the earth wire. The aerial can be of the telescopic rod type, or can be of wire rigged on the lifeboat's mast or suspended from a kite or balloon, which would also help searching vessels or aircraft to find the lifeboat.

The radio receiver is tuned to the distress frequency of 500 kilocycles. The lightweight headphones are permanently connected to the set by a cable led through a gland in the control panel and the panel itself is resistant to spray from sea water.

The transmitter is crystal-controlled and can be switched to either 500 or 8,364 kilocycles. For sending messages a hand key is fitted, but automatic transmission of the S.O.S. signal, followed by a long dash for direction-finding purposes, is also provided so that the set can be operated by untrained personnel, the necessary controls being simple and clearly marked. When automatic transmission is used on 500 kilocycles the auto-alarm signal precedes the S.O.S. The instructions for operating the set are mounted on the side of the case.



Current for this portable marine transmitter and receiver is provided by a manually-operated generator in the base. The set can be tossed into the sea from the deck of a ship and will float until picked up.

REFUSE DISPOSAL PLANT

30 TONS OF REFUSE HANDLED EVERY EIGHT HOURS

A plant for the separation and incineration of local refuse has recently been installed in the Urban District of Aireborough, Yorkshire. Up to the time of its completion, refuse had been tipped in disused quarries in various parts of the district. It will serve a district covering 6,856 acres with a population of 27,533. The work of erection was carried out under the supervision of the chief sanitary inspector, Mr. J. Farrar, A.M.I.P.C., M.S.I.A., and the work of levelling the site, roadmaking and erection of ancillary buildings and equipment was undertaken by Mr. F. Tunnel, B.Sc.(Eng.), A.M.I.C.E., M.I.Mun.E., surveyor and engineer. The main contractors for the plant were Heenan and Froude, Limited, Worcester.

The site of the new plant is at Yeadon, adjoining one of the main trunk roads through the district and it is centrally placed in the area served. The disposal plant and auxiliary buildings occupy about two acres and a further six acres adjacent to it are used for tipping clinker and dust. All the material that can be salved will be claimed from the refuse and where markets are available be sold to form a source of income for the department. Materials salvaged under the district's previous controlled-tipping and partial salvage scheme from April 1, 1940, to March 31, 1954, totalled 4,303 tons and sold for £30,760.

The new plant consists of refuse-disposal machinery arranged to take full advantage of the different levels of the site. The handling and screening sections are designed to deal with 30 tons of crude refuse per eight-hour day, and the incinerator at the end of the conveyor line is expected to consume about 12 tons of tailings – refuse which cannot be reclaimed – in the same period.

A weighbridge is installed at the entrance to the site and the tipping floor, where the contents of refuse-collecting vehicles are discharged into a 30 cub. yd. reception hopper, is approached by a short private roadway. The tipping beam is sufficiently long to permit three vehicles to discharge their loads simultaneously. The hopper is constructed from steel plate and in the bottom there is a slow-moving plate conveyor, which delivers the refuse to a 36-in. belt conveyor. The belt conveyor then carries the refuse to the top floor of an adjacent building for screening.

The screen equipment is of the revolving-barrel type and is driven through rubber-tyred rollers and a reduction gearbox by an electric motor. There are two gauges of mesh surrounding the barrel, one of fine section for the removal of dust and a second of larger section for the removal of cinders. The refuse is propelled through the barrel by a large helical screw, which runs the length of the barrel and acts as a conveyor and agitator.

The materials passing through the mesh fall into dust and cinder hoppers installed directly below. The dust hopper has a capacity of about 4 tons and the cinder hopper about 2½ tons. At the bottom of both hoppers gear-operated roller doors are fitted and through these the contents are discharged to vehicles waiting below.

The remainder of the refuse passes from the screening barrel to a 30-in. wide belt which carries it through the salvage room, where by workmen standing alongside the belt sort the refuse manually. Materials such as rags, bones and paper are removed at this stage. For lowering the salvage products to the ground floor a power-operated lifting block and overhead beam have been installed.

The final stage of sorting, which is shown in Fig. 1, above, is carried out by an overhead-type of electro-magnetic separator running crosswise above the belt carrying the refuse. It removes ferrous metals such as tins, scrap iron and nails. The magnet of the separator, which is energised by direct current from a rectifying unit, attracts the metal to the surface of a moving belt passing beneath it. As the belt of the separator moves past the magnet the field of attraction weakens and the scrap metal is discharged at the side of the main refuse-carrying belt, falling down a chute to a container on the ground floor. To ensure that the extracted metal moves forward with the belt of the separator, slats are attached to the belt's outer surface; these can be seen in the illustration.

The belt carrying the refuse ends above the charging containers for the two-cell incinerator. A simple manually-operated flap valve in the containers allows the operator to feed the waste to either side. The material is charged to each cell by withdrawing a trap door, lined with firebrick, which is mounted on four wheels and runs on a short length of track set in the floor.

Each of the cells of the incinerator contain a grate of the mechanically-clinkered trough pattern specially designed for burning household refuse down to a residue in the form of a single block of clinker. The clinker is removed by a sliding drawbar fitted in the bottom of each grate and operated by an electrically-driven winch. The winch motor is mounted externally on the clinker floor. For transporting the clinker an overhead track carrying a skip is provided as shown in Fig. 2.

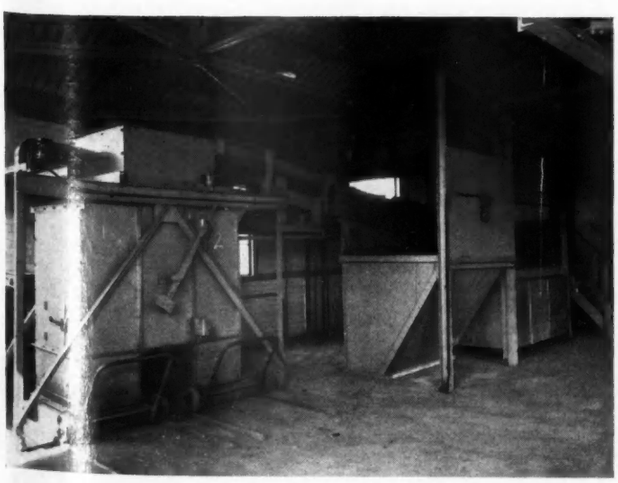


Fig. 1 The conveyor belt ends above two containers from which the waste is charged to the incinerators below. Above the belt is a magnetic separator for removing tins and ferrous metal.

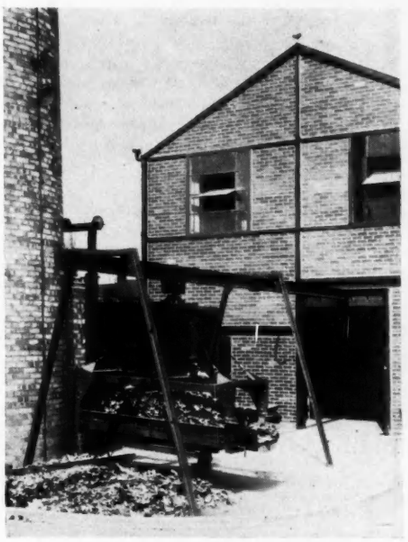


Fig. 2 The skip is used for carrying clinker withdrawn from the incinerators by a drawbar, which is built in the bottom of the grate and operated by a winch motor.

The whole of the incinerator settings are constructed in steel plate to form a rigid box carrying the furnace castings and firebrick linings. A special feature of the construction is the air-cooled arch castings to the clinker doors.

In the combustion chamber alongside the incinerator the gases from the burning waste are thoroughly mixed and consumed; this chamber is also used for the cremation of carcases, condemned meat and other bulky articles. For cleaning and inspection a large door is fitted to the chamber. The combustion of the waste material is assisted by a forced draught provided by a centrifugal fan, and individual control valves are fitted in the ducts through which the air is fed to each grate.

The gases are eventually discharged from the brick chimney stack shown in Fig. 2, erected by Topping and Leggat, Limited, London, N.13. Before this takes place the gases pass through a dust catcher of the water type situated between the combustion chamber and the stack. The flow to the stack is regulated by a firebrick-lined control damper in the flue connecting the dust trap with the stack. The chimney is 100 ft. high and is lined with firebrick throughout.

Push button controls have been fitted throughout the plant for the purpose of stopping the machinery in an emergency. The company responsible for the electrical installation work were Shaw, Dale and Company, Limited, Leeds.

Collecting hoods are installed over the reception hopper and at other points on the handling plant where flying dust might cause a nuisance. These hoods are connected by ductings to two extractor fans, which discharge into filters. The dust is collected and removed in paper bags. To save power a separate fan, which can be switched on and off as required, is provided for

the tipping section. The plant for the collection of dust was provided by Newton Collins, Limited, Birmingham 5.

The weighing machine at the entrance to the yard is housed in a small building. Adjacent to it there is a canteen and lavatory service. The buildings, which enclose the plant are of steel-framed construction with brick panel walls and asbestos-cement sheet roofing. Both buildings are fitted with windows wherever practicable and, to provide access to the various levels at which the plant is installed steel, walkways are fitted. The concrete foundations for the disposal plant buildings were prepared by Halst and Company, Limited, Berkhampstead, and the contractor responsible for the building was Mitchell Yeadon and Sons, Limited, Yeadon.

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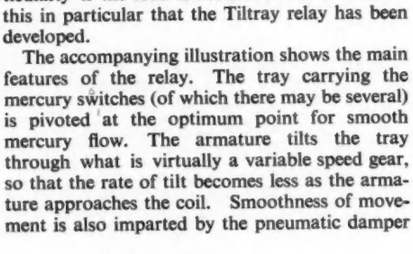
MERCURY SWITCH RELAY

Smooth Operation Avoids Contact Flashing

An addition to the range of relays made by Besson & Robinson, Limited, 6 Government Buildings, Kidbrooke Park-road, London, S.E.3, is the " Tiltray " mercury-switch relay which is designed for very smooth operation. Mercury switches are capable of handling surge currents, both alternating and direct, up to many times their normal rating. Being totally enclosed, they are not subject to deterioration by weather conditions and can safely be used in inflammable atmospheres. Heating may occur however, if there is splashing of the mercury during operation, causing multiple makes and breaks, particularly if the load is inductive. It is to avoid this in particular that the Tiltray relay has been developed.

The accompanying illustration shows the main features of the relay. The tray carrying the mercury switches (of which there may be several) is pivoted at the optimum point for smooth mercury flow. The armature tilts the tray through what is virtually a variable speed gear, so that the rate of tilt becomes less as the armature approaches the coil. Smoothness of movement is also imparted by the pneumatic damper which controls the tray movement when the armature drops out. In this way a coil can be used which will operate at a 30 per cent. voltage reduction without risk of damage by violent operation should the voltage rise above normal.



This relay mechanism is designed to give smooth flow of the mercury under varying operating voltages. The rate of tilt of the switch is almost constant and is steadied by a pneumatic damper.

These relays are available for operation at any voltage up to 500, either alternating or direct current. Coil consumption varies from 5 to 15 VA on alternating current or from ½ to 2 watts if direct current is used. Five mercury switches of 6-amp. rating can be fitted, four of 15 or 30 amp. or three of 60 amp. Impulse switches, which close for about ¼ sec. when the relay operates but not when it returns, can also be fitted. There is provision for auxiliary contacts, operated by an extension of the armature, if required. A simpler design of relay is also made which gives sufficiently smooth operation for most purposes over a reasonable range of operating voltages.

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MOBILE WORKSHOP CRANE

5,000 *lb. Lift*

A portable crane for use in workshops has been introduced by Chamberlain Industries, Limited, Staffa Works, Leyton, London, E.10. It is known as the Staffa-2. The total lift of the crane is 6 ft. and the maximum load that can be raised is 5,000 lb. The jib can be set before lifting commences to either 7 ft. 3 in. or 10 ft. 3 in. above the ground surface. The length of chain carrying the hook can also be adjusted to vary the height of clear lift. The illustration above shows the crane in the finished state.

The jib and column are made from steel plate and mounted on a base frame having two steel tube outriggers. A 7-in. diameter wheel is fitted to the end of each outrigger and, beneath the rear of the base frame, twin wheels also 7 in. in diameter are mounted in a small carriage which is free to pivot and can be steered by a towing handle.

When the crane is in use the rear of the base frame is lowered so that it rests on the ground; this ensures complete stability during the lifting operation. To raise it on to the front wheels so that it becomes mobile the towing handle is lowered until the carriage slips into position. The wheels can be retracted by a similar movement.

Actual lifting of the load is carried out by a ram, which is attached at one end to the base frame and at the other to the under-side of the jib by trunnion, type fittings. The ram is extended by hydraulic pressure from a hand-operated pump, which is mounted at the bottom of the crane column with the reservoir for the hydraulic fluid adjacent to it.

The pump is the makers' Duo two-stage unit with two alternative rates of delivery and two maximum working pressures. With both pistons of the pump working the output is 4·5 cub. in. per stroke, the maximum working pressure of 630 lb. per square inch, and 24 strokes of the pump handle are sufficient to raise the lifting hook through the total lift of 6 ft. For raising heavy loads the larger piston of two is disconnected by means of a manual changeover device. The jib is then raised by the one remaining piston; this arrangement gives a pump output of ⅓ cub. in. per stroke at 5,000 lb. per square inch and 320 strokes of the pump handle are necessary to give the total lift of 6 ft. The changeover device can be used to enable quick take-up of the slack in the chain on the lower pressure setting and then adjusted to the full-load setting. The load is lowered by opening a needle valve, which allows the oil from the ram to return to the reservoir.

This mobile workshop crane has a total lift of 6 ft. which can be obtained with 24 strokes of the pump handle for light loads.

The hydraulic ram has a stroke of 24 in., a bore of 2⅜ in. and develops a maximum thrust of 10 tons at a pressure of 5,000 lb. per square inch. It is the single-acting type and will return to its normal position under the weight of the jib, once the valve has been opened. A flexible hose has been used for connecting the ram to the pump.

The overall width across the outriggers is 5 ft. 6½ in. and the clear space between is 4 ft. 5½ in. The overall length with the towing handle lowered is 10 ft. 6 in. With the jib lowered and the chain and hook extended the hook hangs 1 ft. above the ground and with the chain shortened this distance can be increased to 3 ft.

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ACCIDENT PRECAUTIONS IN THE CEMENT INDUSTRY

The decline in the number of accidents occurring at the works of member firms belonging to the Cement Makers' Federation continued during 1953, according to the third annual report of the Federation's accident prevention advisory committee.

In 1950, in which year the committee was inaugurated, there were 550 lost-time accidents during 27,332,000 man-hours, giving an accident frequency rate of 2 per 100,000 man-hours worked. This is compared with 433 lost-time accidents during 28,292,000 man-hours in 1953, which represented an accident frequency rate of 1·53 per 100,000 man-hours.

Falls of persons were by far the most frequent cause of accidents and, as in 1951 and 1952, mishaps of this nature, which may be grouped under the general heading of " tripping, slipping, striking and handling," together with those caused by objects falling, were responsible for some 70 per cent. of the total number of accidents for the year 1953. Accidents caused by machinery were responsible for only about 6 per cent. of the total number for the year.

An important factor in preventing foot injuries has been the more general use of the steel toe-cap in boots. These boots, which are sold to workmen at cost price, are becoming increasingly popular. Injuries to eyes continue to be a matter for considerable concern. Numerous varieties of goggles, eye-shields and other protective devices are on the market, but the difficulty, the committee emphasises, is to persuade workpeople to use them.

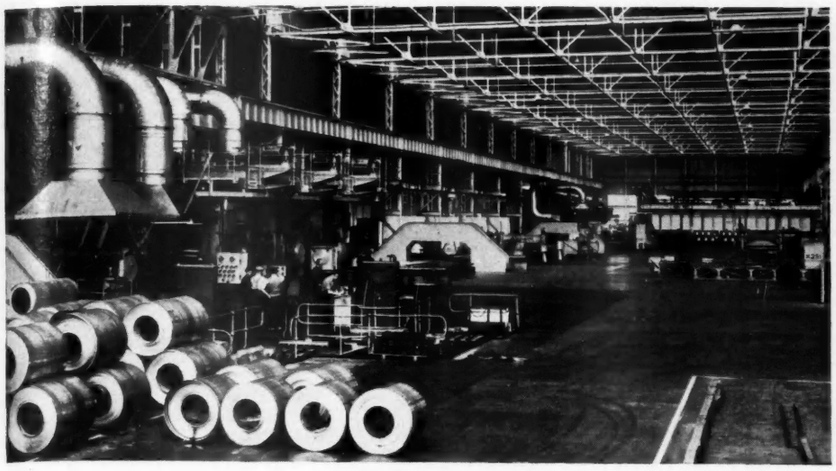


Fig. 1 General view of the hot rolling mill line with a preheating furnace in the background.

ROLLING MILL FOR ALUMINIUM SHEET AND STRIP

SOUTH WALES PLANT OF T.I. ALUMINIUM, LIMITED

The firm of T.I. Aluminium, Limited, as the initials indicate, is a unit of the Tube Investments Group, whose parent company, Tube Investments, Limited, first entered the field of aluminium fabrication in 1932 when they began the production of aluminium tubing, shortly followed by extruded sections. Their principal market was the aircraft industry. War-time demands necessitated an urgent expansion of output and, in 1940, under the aegis of the Ministry of Aircraft Production, a new factory was laid out at Redditch, Worcestershire. Another factory was erected for the Ministry at Redditch in 1942. Both of these plants were acquired by the firm after the war, for their own purposes.

Before the war, however, they had also set up, at Oldbury, a mill for the production of aluminium-alloy sheet and strip. This branch of their activities developed rapidly, so that further capacity became essential; and a study of the market indicated that the greatest potential demand was likely to be for standard sheet and strip of pure aluminium and in light alloys not requiring heat treatment, suitable for deep drawing and forming and having close dimensional tolerances and a high quality of surface finish. It was decided in 1946, therefore, to establish a plant for this purpose. The result is to be seen in the new Rheola Works at Resolven, near Neath, Glamorgan, which we recently had the opportunity to inspect.

The site, in the Vale of Neath and about six miles from Neath itself, had been partly developed by the South Wales Aluminium Company, who erected there a reduction plant for the production of aluminium from alumina; but there was sufficient land adjacent for the construction of the designed rolling mill. As the project has materialised, some of the original buildings have been incorporated in the mill plant. Electricity and water supplies were already available, and there was good road and rail access. Most of the buildings are new, however, and comprise three main bays, each 840 ft. long and 95 ft. span, with a total floor area of 272,000 sq. ft. Except for the rows of columns, at 33-ft. centres, between the bays, the whole of this area is completely unimpeded.

SCOPE OF THE PLANT

Briefly stated, the plant receives aluminium ingots, mainly from Canada, and produces sheets and coiled strip; but it is also equipped to supply corrugated sheets, and circles or other shaped blanks, suitably heat-treated, and slugs for impact extrusion.

The ingots are melted in the foundry and cast into rolling slabs, usually 50 in. by 10 in. in cross-section and 13 ft. long. The slabs are sawn to length, "scalped" (i.e., milled to remove the cast surface) and conveyed to the preheating furnaces which supply the hot mill line, a general view of which is shown in Fig. 1, above. The weight of each slab, at this stage, may be up to 3,500 lb. The hot mill line reduces the slab from a thickness of 10 in. to a strip 0·062 in. minimum, which is then coiled, unless it is required in sheet form; for, as it leaves the hot mill, the material is suitable for many purposes.

If it is to be cold-rolled, the coils are edge-trimmed and, if necessary, slit to a less width before being conveyed to the cold-rolling line, from which they emerge in coils up to 4 ft. wide and with a minimum thickness of 0·014 in. In the same bay as the cold-rolling line are two levelling and shearing lines, which produce flat sheets up to 20 ft. long, and a roll-forming line for the production of corrugated sheets. In another bay, at right angles to the cold-rolling line, is a "Stamco" shearing line for the production of sheets that are required to close dimensional accuracy, and a continuous flash annealing furnace.

An additional building is under construction which will contain two-high rolling mills with individual drives, and another heat-treatment furnace. Some of this plant will be new, but a part is to be transferred from the older plant at Oldbury. In this extension will be produced, as well as flat sheets up to 6 ft. wide and 20 ft. long, a number of special types, such as lustre-finished cold-rolled sheet, tread plate, and patterned sheet. Corrugated sheet will be produced on the forming machine shown in Fig. 2.

DETAILS OF BUILDINGS

As mentioned above, many of the buildings of the original plant of the South Wales Aluminium Company have been incorporated in the new mill. In all, these buildings have a floor area of about 200,000 sq. ft. Two of the original shops, which contained the aluminium-reduction furnaces, have been cleared, equipped with overhead cranes, and are now used for slab preparation. The original foundry building, which adjoins them, is still so used, but has been considerably extended. Another, also extended, is now the laboratory.

The three main bays of the mill, which, as stated above, are 840 ft. long and 95 ft. wide, have a height to the underside of the roof girders of 38 ft. 6 in. The roof is of north-light form, with the ridges across the bays, and is fitted with continuous glazing mounted in aluminium bars. The reverse slopes are covered with Ruberoid. The walls are of brick to a height of 9 ft., and above them are aluminium-framed windows with opening lights, supplied by Mellowes and Company, Limited, of Sheffield. The structural steelwork, amounting to about 2,000 tons, was supplied and erected by Rubery, Owen and Company, Limited, Darlaston, and supports gantries on which run six 25-ton cranes, supplied by the Clyde Crane and Engineering Company, Limited, Mossend, Lanarkshire.

On the south side of the main bays is a brick lean-to building about 400 ft. long, containing the motors driving the hot mill line, and a brick cooling tower for the soluble oil. This building has aluminium roof trusses and decking, and is provided with aluminium-framed windows, supplied by the Monk Metal Window Company, Limited, Birmingham. On the north side of the main bays is a two-storey building containing the works offices and also the house for the motors driving the cold mill line.

At right angles to the north main bay is the inspection and dispatch department, a steel-framed building 220 ft. long and 90 ft. wide, and 38 ft. high to the eaves. It has a pitched roof, with Ruberoid covering where it is not glazed, and continuous glazing in the side walls. As in the case of the main bays, the steelwork was supplied and erected by Rubery, Owen and Company. The 10-ton overhead travelling crane, by the Clyde Crane and Engineering Company, is unusual in having a gantry constructed in aluminium.

The new sheet-mill building, mentioned as being still under construction, is of the box portal type with a pitched roof and welded framing. Again, the steelwork contractors are Rubery, Owen and Company. It is 400 ft. long, 70 ft. span, and 28 ft. high to the eaves. There are four rows of continuous aluminium roof glazing and, on both sides and ends, aluminium-framed windows from the top of the 9-ft. brick wall to the eaves; these windows were supplied by Henry Hope and Sons, Limited, Smethwick. All gutters, downpipes, etc., are of aluminium and were supplied by E. C. Payter and Company, Limited, of Tipton. The roof covering is also of aluminium. At one end of the shop is an additional bay, of similar construction, which will eventually form the heat-treatment department.

CASTING AND PREPARATION OF SLABS

The foundry contains six reverberatory gas-fired melting furnaces, built by Gibbons Brothers,

Fig. 2 Multi-roll forming machine used for putting corrugations into aluminium sheet.

Limited, of Dudley, each having a holding bath into which the molten aluminium flows by gravity. The furnaces are arranged in pairs, with a semi-continuous casting machine between each pair. In two pairs of furnaces the melting hearth and the holding bath hold 13 tons and 7 tons of metal, respectively, and in the case of the third pair, the hearth and the bath hold 10 tons each; this is the most recently installed pair. Samples are taken at intervals from the holding baths and, in the adjacent laboratory, are analysed electronically by means of a quantometer, which provides a rapid indication of the percentage of the different elements in the melt; as many as 13 constituents can be thus measured, if so many are present. The analysis occupies only a few moments and the result is signalled to the foundry before each cast is commenced.

The method of casting is to tap the molten metal into a water-cooled die, the bottom of which is the table of a ram that is slowly lowered, as casting proceeds, under the control of a hydraulic pump unit supplied by Weatherley Oilgear, Limited, of Stockport. As the metal solidifies in the cooled die, the ram is steadily lowered, under an infinitely variable speed control, until a slab of the full desired length is obtained. Automatic flow valves in the launders between the holding bath and the die regulate the rate of pouring. The largest slabs, with a cross-section of 50 in. by 10 in., are cast in pairs, the total weight per cast being 6 tons. If a smaller section is required, the number of slabs cast at one time is correspondingly increased.

From the casting machines the slabs are transferred to the slab preparation shop, where they are cut into lengths on fluid-feed sawing machines, with saws 38 in. in diameter; these machines were made by Noble and Lund, Limited, Felling-on-Tyne. The next operation, which is scalping, is performed on vertical-spindle machines, constructed by John Holroyd and Company, Limited, Rochdale, by dynamically-balanced cutters, 51 in. in diameter, which have a peripheral speed of 6,000 ft. per minute. The machines are arranged in pairs, with turnover gear between, so that both sides of the slab can be finished. The slabs are then lifted by crane on to a conveyor, on which they travel to the preheating furnace at the head of the hot-mill line.

HOT ROLLING

The two double-chamber preheating furnaces, by Gibbons Brothers, Limited, are gas-fired and are 9 ft. wide by 5 ft. 3 in. high, with a length of 63 ft. Forced air circulation is used, in nine separately-controlled zones. The control instruments, valves, etc., were provided by George Kent, Limited, Luton. The slabs are placed on end before entering the furnace and are discharged directly on to the live-roller feed table of the hot mill by means of a handling machine designed by Messrs. E. H. Weston, Limited, of Hatfield, Hertfordshire, and constructed by the Birtley Engineering Company, Limited. This machine, which is shown in Fig. 5, opposite, turns the slab over so that it can be inspected on both sides before it passes into the hot mill.

The machine is hydraulically operated, the clamping action being effected by a telescopic cylinder and the turn-over by a separate cylinder, having a rack on the piston end. The greatest size of slab that can be turned over on to the mill table is 50 in. wide by 6 ft. 6 in. long and 10 in. thick, representing a weight of about 4,000 lb. Smaller slabs, up to 26 in. square and 5 in. thick, can be handled two at a time. The working pressure of the hydraulic system, which is independent of the others associated with the hot mill, is 1,700 lb. per square inch.

A notable feature of the machine is the completeness of its safety and control devices, the main hydraulic circuit having in it eight smaller interlocked circuits. There are four combinations of circuits by which either of the two hydraulic pumps can actuate either of the two machines; there is one machine to each preheating furnace. If a pipe should burst while the machine is actually handling a slab, the turning operation would stop, but the slab would still be gripped tightly. It is impossible to turn a slab over unless it is properly clamped, and it cannot be unclamped while turning is in progress. As the slab passes the vertical and begins to descend on to the mill table, separate hydraulic circuits come into play to control the speed of descent and, finally, to brake the machine so that the slab is deposited gently on to the rollers. There is also a levelling mechanism to ensure that, even if the slab is gripped unevenly, it is deposited in a level position, irrespective of its thickness; and it is impossible to start the return movement of the arms until unclamping is complete. The machine is fitted with its own automatic lubricating system.

The two-high reversing hot mill which breaks down the slabs was constructed, together with its roller tables and manipulators, by the Brightside Foundry and Engineering Company, Limited, Sheffield. The rolls are 35 in. in diameter and 80 in. in width. They are supported in fabric bearings and are driven by a direct-current motor of 2,000 h.p. which can give rolling speeds up to 475 ft. per minute. The normal maximum weight of slab is 3,500 lb., and this can be broken down to a thickness of 0·25 in. in eleven passes. The feed table is 138 ft. long and the run-out table, which is divided into four separately-controlled sections, is 500 ft. long.

Beyond the hot mill, and between it and the tandem mills, there are: a 1-in. by 98-in. up-cut shear, an edge trimmer, and a ⅜-in. by 54-in. up-cut shear. The edge trimmer, which has cutters 21 in. in diameter, adjustable to a width of 70 in., was supplied by the Loewy Engineering Company, London, and the two shears by the Head Wrightson Machine Company, Limited. Four pairs of side manipulators are provided, namely, one pair on each side of the hot mill, one pair by the edge trimmer, and one near the ⅜-in. up-cut shear.

On leaving the hot mill, the slab – or strip, as it has become – has its ends trimmed in the ⅜-in. shear and then enters the three-stand four-high tandem mill, constructed by W. H. A. Robertson and Company, Limited, Bedford; at this point, the temperature of the metal is about 350 deg. C.

The tandem mills, shown in Fig. 4, below, have work rolls 17 in. in diameter and 60 in. long, and backing rolls 42 in. in diameter. All the rolls are carried in roller bearings. Each stand is driven by a direct-current motor of 1,500 h.p. The rolling speeds are up to 200 ft. per minute on the first stand, 420 ft. on the second, and 500 ft. per minute on the third stand. At the exit end of the mill is a drum coiler which can deal with material up to ¼ in. thick and 50 in. wide, producing coils 34 in. in diameter. Thicker material is dealt with on a three-roll coiler. The coils are transferred by a gravity conveyor to a weighing machine and thence to a cooling conveyor.

FINISHING LINES

From the tandem mills, the coils which require further processing are taken to three annealing furnaces, supplied by the Stordy Engineering Company, Limited, Wolverhampton. Each furnace is equipped with an up-ender, loading crane, and charger, and can treat two tons of material an hour. External heaters are used, and are designed to run at 140, 215 or 280 kW, or any combination of these ratings.

In the cold-rolling line, the two main units are 17 in. by 42 in. by 60 in. four-high non-reversing strip mills, with conveyors and roller bridles on the in-going side, and belt wrappers and drum coilers on the out-going side. The first mill was supplied by W. H. A. Robertson and Company, who also provided the auxiliary equipment on the second mill, which was constructed by the Davy and United Engineering Company, Limited, Sheffield. The drive is by direct-current motors of 1,500 h.p., and the maximum rolling speed is 1,000 ft. per minute. A typical reduction is from 0·030 in. thick to 0·014 in. on coils 50 in. wide, weighing 3,000 lb. each.

Material required to be temper-rolled is taken from these mills, after further annealing, to a two-high non-reversing strip mill with rolls 18 in. by 48 in., constructed by W. H. A. Robertson and Company and designed to reduce strip from 1 mm. thickness to 0·30 mm. The decoiler and the coiler on this mill are arranged to provide variable tension.

Other equipment in the cold-finishing line includes an edge trimming and slitting machine, two continuous levelling and shearing lines, a roll-forming machine for producing corrugated sheet, a Yoder precision slitting machine, previously mentioned, and the Stamco precision

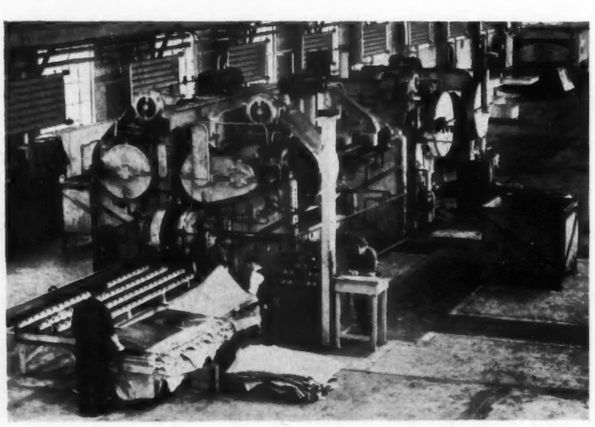


Fig. 3 The "Stamco" precision sheet-trimming line with a flash-annealing furnace in the background.

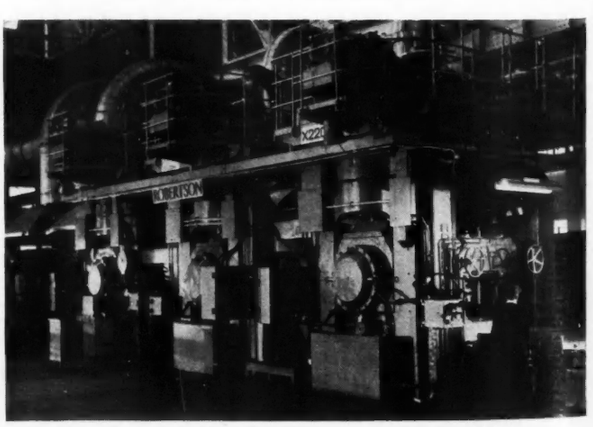


Fig. 4 A three-stand 4-high tandem mill. Rolling speeds reach 500 ft. per minute on the third stand.

sheet plant, to which reference has also been made and which is illustrated in the foreground of Fig. 3 opposite.

The machine for edge trimming and slitting, which was supplied by the Loewy Engineering Company, is fitted with a recoiling train which can operate at speeds up to 500 ft. per minute. It is driven by electric motor through Vickers V.S.G. hydraulic units and can maintain a tension on the strip of 5,000 lb. The two continuous levelling and shearing lines were supplied, with their various accessories, by W. H. A. Robertson and Company. One will take strip up to 48 in. wide and the other up to 54 in. wide, it being supplied to the machines in coils and delivered in sheets of any desired length from 30 in. to 20 ft. The strip is cut into sheets by Hallden flying shears. Both lines will work at speeds up to 300 ft. a minute. The cut and flattened sheets are transferred by belt conveyors to a stacking frame.

In line with the 54-in. shearing train and its delivery conveyor is the roll-forming machine, which is driven by a 60-h.p. motor. It was built to the designs of T.I. Aluminium, Limited, by Fred. Gilbert (Cardiff), Limited, and will work up to the same speed (300 ft. per minute) as the Hallden line which feeds it.

Additional roller levellers, and hydraulic stretching machines, are provided to deal with sheets which are required to have a high degree of flatness. These can be made, if desired, from material taken direct from the hot mill, in which case they are first cut to length by intermediate shears, supplied by Joseph Rhodes and Sons, Limited, Wakefield. For the precise side and end trimming of levelled sheets, there is a Stamco automatic shearing line, supplied by the Head Wrightson Machine Company. It consists of two pairs of guillotine shears, one pair to trim the sides and the other pair the ends; the adjustments of relative position, effected by moving the shears bodily, are made by electric power. Sheets for trimming are fed through the unit on a conveyor belt.

Power presses are provided for blanking small circles and other forms, and for discs of larger size there are circle-cutting machines, made by Brookes (Oldbury), Limited. The blanks thus produced usually require annealing, and this is done in the flash-annealing furnace, constructed by the Stordy Engineering Company. This furnace is about 100 ft. long and consists of a heating chamber through which air is circulated at a high temperature. The heating elements are of the electrical resistance type and are outside the heating chamber.

OIL COOLING AND FILTERING EQUIPMENT

In the reference to the motor house which adjoins the main rolling-mill bay, it was mentioned that, associated with it, there is a brick cooling tower for dealing with the soluble oil as it comes from the mill. The main supply of soluble oil is contained in a storage tank with a capacity of 50,000 gallons, which is provided with electric immersion heaters to maintain the oil at a constant temperature, especially when the plant is shut down at week-ends. The cooling tower prevents any undue temperature rise when the mill is working.

The oil is circulated to the mills at the rate of 2,000 gallons per minute and a pressure of 60 lb. per square inch by two centrifugal pumps, supplied by the Pulsometer Engineering Company, Reading, and driven by motors of 120 h.p. From the mills the oil drains into glazed cooling and filtering tanks from which it is pumped to the cooling tower by two Sulzer vertical-spindle pumps.

The two four-high cold-rolling strip mills have their own oil-cleaning plant. Three of the Harland Engineering Company's "Duoglide" pumps deliver oil to the mills and three similar pumps, drawing from the drain tanks, pass it through a battery of Autoklean "Lolos" twin cartridge strainers, each with a capacity of 3,000 gallons an hour. After leaving the strainers the oil flows to a tank, holding 10,000 gallons, from which it is delivered through four Stellar filters to the storage tank, whence it is recirculated. A similar plant, but of smaller size, is provided for the two-high temper mill.

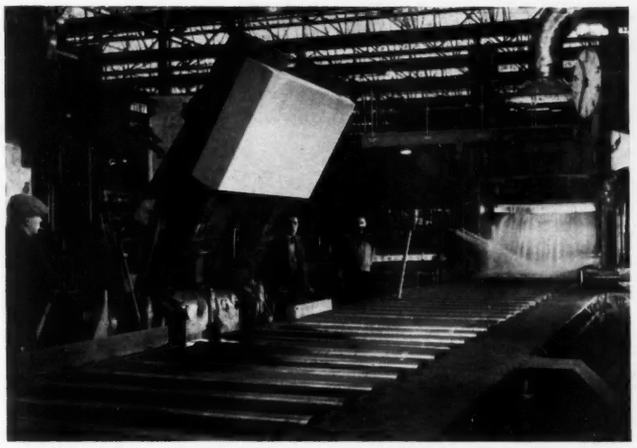


Fig. 5 Hot slabs are transferred from the preheating furnace on to the feed table of the hot mill by the manipulator shown here. This machine turns the slab over so that it can be inspected on both sides before passing into the hot mill.

ELECTRICAL EQUIPMENT

The electricity supply to the plant is taken from the Grid at 66,000 volts and is reduced to 6,600 volts by means of two outdoor transformers, each of 15,000 kVA capacity, supplied by the English Electric Company, Limited. The 6,600-volt supply is remotely controlled through a 250-MVA switchboard, also supplied by the English Electric Company, on which are two 1,600-ampere incoming circuit-breakers and three outgoing breakers of 800 amperes capacity each.

Current for the foundry is taken directly from the main switchboard at 6,600 volts through a 0·15 sq. in. cable and is reduced to 415 volts by two 750-kVA transformers, supplied by the Metropolitan-Vickers Electrical Company, Limited. The supply of current for the rolling mill is taken from a ring main consisting of two 0·3 sq. in. aluminium-sheathed cables in parallel, provided by Johnson and Phillips, Limited.

All the main drives are taken directly from the 6,600-volt circuit through ring-main switchgear units suitably disposed; and low-tension alternating current is obtained from three 1,000-kVA and two 750-kVA transformers with delta-star windings having the neutral solidly earthed, for all of which the contractors were the English Electric Company. The same firm also supplied the 17-panel airbreak switchboard which is fed from the 1,000-kVA transformers. Each outgoing circuit on this board is equipped with the usual overload protecting and earth-leakage relays. The switchboard is in three sections, connected by switches which are normally open except at week-ends, when one transformer is sufficient to cover the usual requirements.

The two 750-kVA transformers, usually run in parallel, are controlled by two 1,600-ampere incoming oil-immersed circuit-breakers and three 800-ampere outgoing circuit-breakers, all of which were supplied by George Ellison and Company, Limited.

Power for small tools and portable lights is obtained from 3-kVA double-wound 415/110-volt transformers, with the secondary centre point earthed; these were supplied by F. C. Heayberd and Company, London.

Lighting in the main rolling-mill bay is by means of blended-lighting units, each comprising a 2½-kW mercury-vapour fitting and a 1½-kW tungsten fitting. These were supplied by the Simplex Electric Company, Limited, and the British Thomson-Houston Company, Limited. The contractors for this installation were the Etna Lighting and Heating Company, Limited, and W. J. Furse and Company, Limited; and for the office block, S. H. Wheeler and Company, Limited.

For the overhead electric travelling cranes, the variable-speed motors on the process lines, the mill screwdown gear, etc., direct current at 460 volts is obtained from a 750-kW mercury-arc rectifier. This consists of four 163-kW glass-bulb rectifiers and two 6,215-kW balance rectifiers and was supplied by the Metropolitan-Vickers Electrical Company. The direct current is controlled by a 14-panel flat-back slate switchboard, with electronically-controlled loading resistance.

MILL DRIVES

As previously mentioned, all the main mill drives are taken from the 6,600-volt system. The hot mill is directly driven by an 1,800-h.p. direct-current reversing motor running at 40/52 r.p.m. and delivering a maximum operating horse-power of 4,950. It is supplied with current through a motor generator set driven by a 2,500-h.p. 6,600-volt induction motor and a 65,000-h.p. second flywheel. This drive was supplied complete by the Metropolitan-Vickers Electrical Company.

The three-stand tandem mill is driven by three direct-current motors of 1,500 h.p. each, receiving their current from two motor generator sets driven by synchronous motors, one of 3,200 kVA and the other of 1,500 kVA. Both are wound for 6,600 volts and are designed to run at unity power factor. These also were supplied by the Metropolitan-Vickers Electrical Company, as also were the exciter sets which automatically control the strip tension and the inter-stand speed.

The 500-h.p. direct-current motor which drives the 18-in. by 48-in. cold mill receives its current from a 405-kW generator driven by a 650-h.p. synchronous motor of unity power factor. Special exciter sets maintain a constant strip tension over a wide range. The 17-in. by 48-in. and 60-in. cold mill is driven by a 1,500-h.p. direct-current motor, supplied with current by two 700-kW generators, all provided by the English Electric Company, Limited. The generator drive motor, of 2,200 h.p. is a 6,600-volt synchronous machine of 0·8 leading power factor. It is directly coupled to the two generators previously mentioned, and to the reel booster and the drag generator. Except in the case of the 18-in. by 48-in. mill, all the screw-down motors are direct-current, of the compound mill type, taking their current from mercury-arc rectifiers at 460 volts.

In the sheet-mill annexe, still under construction, the supply of current will be through an extension of the ring main to a 1,000-kVA outdoor transformer, supplied by the Metropolitan-Vickers Electrical Company, which will provide the necessary low-tension current for the mill drives and the associated plant. Direct current for the cranes in the annexe will be obtained from the main rectifier in the rolling-mill bay. A system of lighting will be installed similar to that in the main mill, with units comprising two 400-watt mercury-vapour lamps and a 1,000-watt tungsten lamp, designed to afford a minimum illumination of 15 foot-candles. It may be remarked that, in the main mill bay, it was found that, after several months' operation without cleaning the lighting fittings, the illumination had not fallen below 18 foot-candles.

Fig. 1 Diagrammatic layout of the coal-gas producer plant for clean cold gas.

TWO-STAGE COAL-GAS PRODUCER

CONTROLLED GASIFICATION AND DISTILLATION

The conventional coal-gas producer has certain well-known disadvantages, both when it is used to supply hot raw gas and when the product is cleaned and used as cold clean gas. If the gas is used in the raw state, there is inevitably some deposition of pitch and soot in the mains, which have therefore to be burnt out periodically. When the gas is cleaned, the primary cooling is accomplished by bringing the gas into direct contact with water. The gas is then fully-saturated, and the tar is removed, together with excess liquor. Separation of the tar and water is then necessary, and the tar must be dehydrated before it can be used. Even then, the tar, since it is contaminated with dust, and partly cracked, is difficult to handle.

The remedy for these defects was found in the two-stage pre-distillation producer, which has been in successful operation on the Continent of Europe for some time. The International Furnace Equipment Company, Limited, Aldridge, Staffordshire, have concluded an agreement with Il Gas Integrale, S.p.A., of Milan, and their associated companies, whereby the British concern becomes the sole licensee to build and install G.I. two-stage producer plants in Great Britain and the Commonwealth countries. Two plants have now been installed in this country, the first at the River Don Works of the English Steel Corporation, Limited, Sheffield, and the second at the Wednesfield, Staffordshire, works of the Weldless Steel Tube Company, Limited.

TWO GAS OFF-TAKES

The diagrams, Figs. 3a and 3b, opposite, show the principle of the two-stage pre-distillation producer, as compared with the orthodox pattern. The conventional producer, Fig. 3a, has only one gas outlet, and all the hot gases from the gasification zone pass upwards through the distillation and drying zones. It is not possible, therefore, to control the rate of distillation of the volatile constituents of the fuel. A deep fuel bed is an advantage, since a reduction in off-take temperature results, but this is all that can be done with the conventional producer. In the case of the two-stage unit, Fig. 3b, there are two off-takes, the lower one taking away a quantity of gas before it can reach the distillation zone. By varying the amount of gas taken by the lower off-take, the amount passing to the distillation and drying zones can be controlled to give the ideal rate and temperature required for the distillation of the volatiles. The two stages of gas production, gasification and distillation, are thus separated and, at the same time, brought under control.

CLEAN OR RAW GAS

The G.I. two-stage producer is designed to work on coal of either the bituminous or lignite type, the swelling power of which does not exceed 2½ as measured by the British Standard test. For the best performance, the coal should be graded and the fines, which are in any case undesirable in any form of producer, should be screened out. Given a suitably graded fuel, for example, 1¼ in. to 2 in. (doubles), or 2 in. to 3 in. (trebles), of the correct type, the producer can work at a thermal efficiency including gas, tar, and sensible heat, of about 0·9 when delivering hot raw gas, or at about 0·75 when the gas is used in the clean cold form. The gross calorific value of the gas generated is about 175 B.Th.U. per cubic foot. The basic element of the plant is the two-stage producer, and to this can be added ancillary equipment as required, so that the product can be hot raw gas, hot de-tarred gas, or cold clean gas, according to need. The gas can be cleaned of tar and the dust content reduced to 0·02 grammes per cubic metre, or less.

FUEL SUPPLY

The fuel, which is received at one of the British plants in rail wagons, and at the other in canal boats, is elevated to a bunker over the producers by a skip-hoist. At this point arrangements can be varied according to the coal being used. A single bunker can, for example, be erected over each producer, with direct discharge into the coal-feed mechanism. This is the arrangement in one of the British plants. Alternatively, two or more bunkers can be provided, with short lengths of variable-speed belt conveyor and a feed hopper, so that different grades of coal can be blended in the required proportion immediately before charging. This arrangement was adopted at the first of the British plants to be installed. A general view of the coal-feeders and control equipment, which are housed together on an upper floor, is shown in Fig. 2, below.

Referring to the diagram, Fig. 1, coal from the bunker or feed hopper (*a*) is fed to the top of the distillation section of the producer through an automatic coal feeder (*b*). The feeder is designed to minimise abrasion of the fuel and so to ensure that dust does not enter the producer, to be carried away with the gas. It consists of two half-cylinders mounted horizontally one above the other, the upper one of which comes to rest with its open part upwards beneath the feed hopper. To charge the producer, this half-cylinder is rotated slowly, to deposit the load of coal it has picked up from the hopper into the lower half-cylinder. The latter then rotates in the same way, and the coal is deposited in the upper zone of the producer (*d*). The very small amount of gas which escapes through the feeder is bled off to atmosphere through a pipe (*c*). Control of the feeder is entirely automatic, a feeder flap inside the producer starting the drive motor when the fuel level falls.

PRE-DISTILLATION

As the coal passes down the upper zone, its temperature rises gently and progressively, and by the time it reaches the lower zone (*e*), its volatiles have been distilled and taken away by the top off-take (*f*). The reactive coke remaining is gasified in the lower zone, which is the same as a conventional producer, and has a revolving water-sealed grate (*g*). Rotation of the grate is automatic, a hydraulic cylinder and ram with ratchet gear being provided for this purpose. Gas from the lower zone can leave either by the main gas off-take (*h*), or by the subsidiary

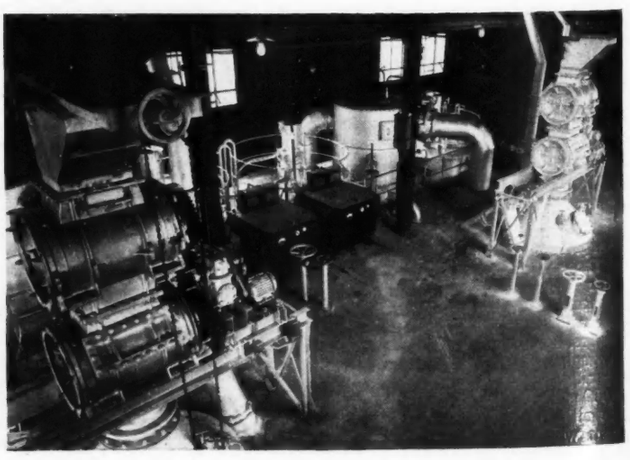
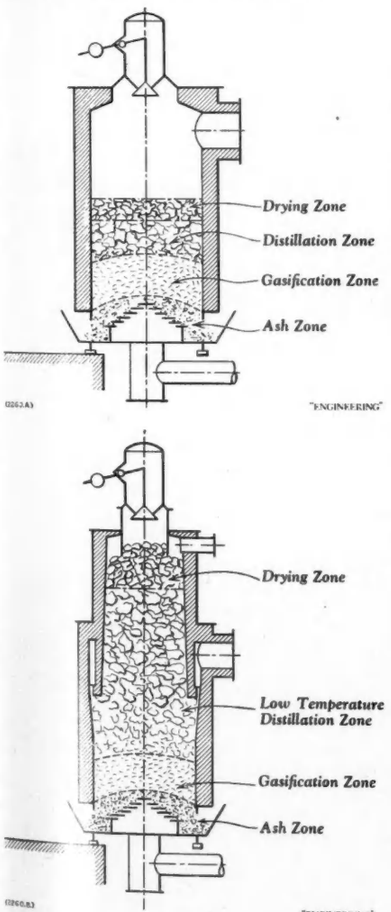


Fig. 2 The automatic coal-feeders, transformers for the electrostatic precipitators, and control equipment for this two-stage plant are all housed on an upper floor.

off-take (*f*). In operation the flow of gas is proportioned between the two off-takes by means of control valves, so that there is just sufficient heat in the distillation zone to effect the proper distillation of the volatiles. The temperature of the top off-take (*f*) is the criterion of this proportioning, and for bituminous coal it is in the range 100 deg. C. to 150 deg. C.

WASTE-HEAT STEAM GENERATOR

The lower section of the producer is surrounded by a water jacket, which serves the double purpose of providing steam for the plant, and cooling the zone to prevent the adhesion of clinker. Steam from the water jacket (*j*) passes to a steam drum (*k*), from which it is drawn to saturate the air blast, and for the steam curtains on the poke-holes at the top of the lower zone. Tar-laden gas from the top off-take passes to a catch-pot (*l*), where a small amount of liquid tar is removed, and thence, with the majority of its tar in the form of a mist, to an electrostatic de-tarrer (*m*). Tar-free gas from the lower off-take passes through a brick-lined cyclone, which removes any large dust particles, and a wash-column (*n*), where it is cooled by water sprays. Both streams of gas then pass to an indirect tubular cooler (*o*), at the top of which they are mixed. In this cooler the temperature is reduced as much as possible, and the gas then passes to a second electrostatic precipitator (*p*), which removes the light oils. Finally, the cold, clean gas enters the distribution main (*q*).



Figs. 3a and 3b These diagrams show the differences in principle between the conventional gas producer (Fig. 3a) and the two-stage pre-distillation producer unit (Fig. 3b) described in this article.

AUTOMATIC CONTROL

The amount of gas produced is regulated automatically by varying the air blast from the fan (*r*), according to the gas demands, as measured by the pressure in the distribution main. Overall control is maintained from a control desk, installed on the charging floor and equipped with manometers showing the pressure conditions throughout the plant, temperature and flow indicators and recorders, water-level indicators, grate-drive control, and other necessary instruments and controls. The only item away from the control panel which requires attention from time to time is the measurement of the depth of the fire in the producer. This is done by steel rods inserted in poke-holes in the top of the lower zone. The poke-holes are provided with steam curtains, which come into operation automatically when the lid is opened.

The plant described is for the production of cold clean gas, but it is obvious that modifications can be made, by the omission of certain items of equipment and the re-arrangement of the remainder, to produce either hot raw gas, or hot de-tarred gas instead. In all cases the producer remains the same, only the ancillary equipment being altered.

THE ROYAL SHOW

Continued from page 61

The 106th annual show of the Royal Agricultural Society of England, held this year by courtesy of Her Majesty the Queen in Windsor Great Park, closed on Friday, July 9, after having been open since the previous Tuesday. The indications are that it was one of the most successful ever held. This is certainly so as far as the implement yard is concerned, considerable interest having been shown in the various machines by many foreign visitors. Several of the new machines on view were described in last week's issue of ENGINEERING, and we continue below our account of the show.

HOP-GARDEN TRACTOR

Of the comprehensive range of wheeled and crawler tractors shown by the David Brown Corporation (Sales), Limited, Meltham, Yorkshire, two were new since last year. One of the new machines, namely, a hop-garden model, is illustrated in Fig. 5, on page 92, where, for the sake of comparison, it is shown beside a standard tractor, the hop-garden version being that to the right of the illustration. It is a modified David Brown 25VO machine, the modifications having been carried out by Drake and Fletcher, Limited, the distributors for David Brown in Kent. The requirements for a tractor for use in hop-gardens, orchards, vineyards, etc., are narrowness and lowness combined with stability. In this case these requirements have been met by modifying the front axle to lower the "nose" of the tractor by four inches and by altering the final drive units to achieve a similar reduction of height at the rear. At the same time, the parts were arranged to reduce the overall width by 5¼ in. Other minor modifications to such parts as mudshields, brake mechanisms, etc., had, of course, to be made, but almost without exception it has proved possible to use standard parts suitably altered. Tests have shown that the tractor has a performance in every way comparable with the standard 25VO machine and that it can be operated in 6-ft. wide gaps in plantations, hop gardens, etc. Furthermore, the modifications have been effected in such a way that nearly all the standard David Brown implements can be fitted to the rear implement linkage of the tractor. In its modified form, the overall length of the tractor is 113 in., the height, excluding exhaust, 51 in. and the width, measured over the rear tyres, 53¼ in. With the silencer in position, the ground clearance is 10 in. and the weight of the complete machine is 3,470 lb.

SPRING-TINE CULTIVATOR

Several new implements were being shown by the David Brown organisation. These included a spring-tine cultivator, a disc ridger and a one-way plough. The new cultivator, which is known as the David Brown "C" type cultivator, is illustrated in Fig. 6, over page. It has been put through extensive tests both in this country and in the Dominions and has proved eminently suitable for inter-row cultivation of potatoes, turnips, cotton, maize, etc., as well as for the general preparation of seed beds. It consists of a single main frame made from 2-in. square tubing to which nine S-shaped flat spring tines, with reversible points, are clamped. Depth control is by two 12-in. diameter cast-iron wheels adjustable for height and fitted with conical bearings which can be taken up to compensate for wear. The tines are provided with helper springs, which are fitted to the upper ends of the mains springs, and they can be set at any required spacing simply by slackening the securing clamps and sliding them along the frame. The headstock is of strong construction with tubular front struts and a U-shaped rear strut and is designed, of course, for use with the tractor three-point hitch. The length of the tool frame is 78 in. and the ground clearance 18½ in.

DISC RIDGER

The David Brown disc ridger is illustrated in Fig. 9, over page. It is manufactured in Rhodesia where it was developed by Bentalls Rhodesia, Limited, for use with David Brown tractors. As will be seen from the illustration, the implement has been designed for attachment to the rear tractor linkage, or three-point hitch, the pitch and levelling levers of the tractor linkage, therefore, being available for adjustment. Depth of working is controlled by a simple screw gear incorporated in the anchorage for the rear trailing-furrow wheel. Two complete ridges are formed as the implement is drawn through the ground, the shape of which can be varied from a sharp-pointed top to a low "V" top by a swivel adjustment on the discs. An unusual feature is the staggering of the discs, it being claimed that such an arrangement reduces the draught and increases, therefore, the speed of working. The discs are made from heat-treated steel and the stub-axle bearings are of phosphor bronze, suitable arrangements being incorporated to exclude dirt, grit, etc. The row width is adjustable by increments of 1½ in. from 2 ft. to 3 ft. 9 in. Although this implement, which, to give it its full title, is known as the David Brown-Bentall disc ridger, has been developed in Rhodesia, it is now available to the home market.

ONE-WAY PLOUGH

The David Brown one-way plough is illustrated in Fig. 7, on page 92. The main advantages of one-way ploughing are: elimination of open furrows and ridges; removal of the need to mark out; and easier and safer contour work.

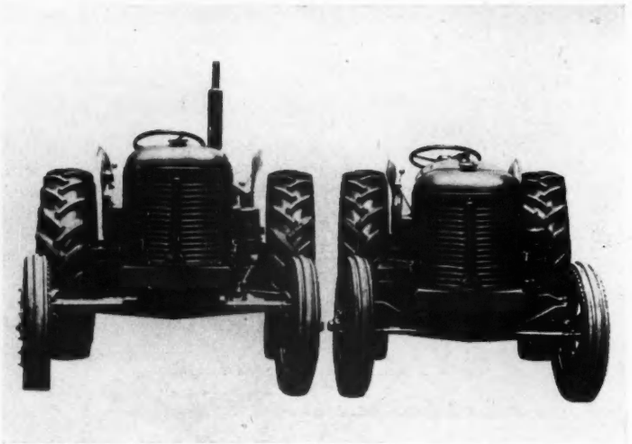


Fig. 5 A standard tractor, shown on the left, and a modified version designed for use in hop gardens.

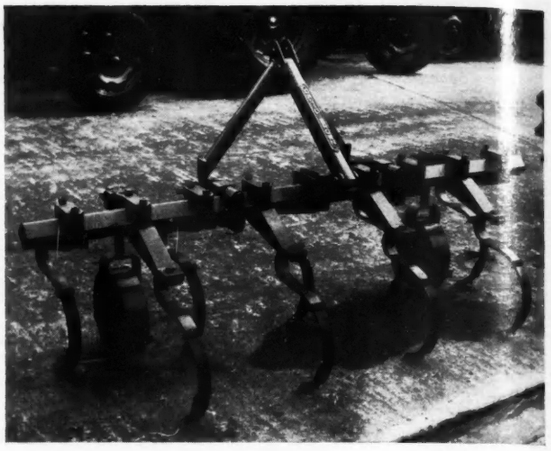


Fig. 6 Spring-tine cultivator suitable for use between rows of potatoes, turnips, cotton, maize, etc.

Fig. 7 A one-way plough. Among the advantages of one-way ploughing is the elimination of open furrows and ridges.

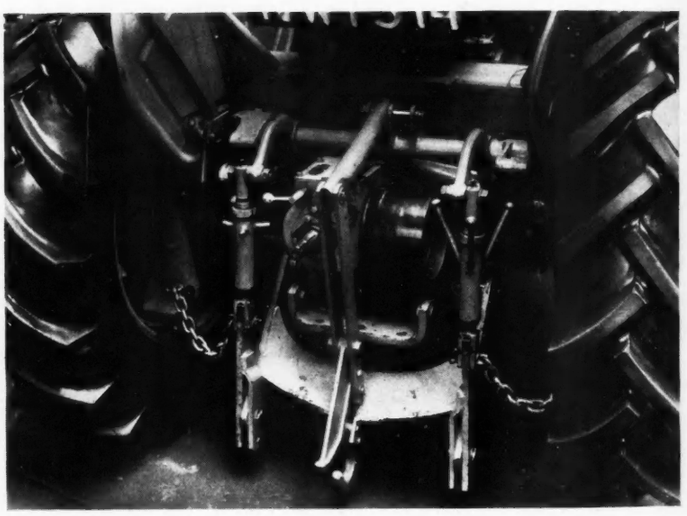


Fig. 8 Automatic tractor hitch for trailer-type implements, making for the ready attachment of the drawbar.

Fig. 9 A disc ridger designed for attachment to the rear linkage of a tractor. Depth of working is controlled by a simple screw gear.

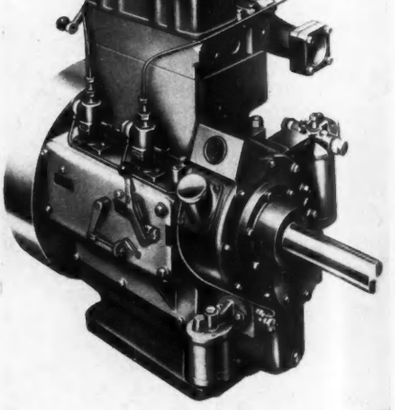


Fig. 10 Twin-cylinder Diesel engine developing 12 h.p. at the maximum speed of 1,500 r.p.m.

As will be seen from the illustration, the David Brown one-way plough consists essentially of two separate bodies and associated beams which are brought into operation alternately. The two beams which carry the skims, coulters and plough bodies, are mounted on, and swing about, a cross shaft and their movements are co-ordinated by means of a wire rope threaded over a pulley fitted to the tractor. When the complete plough is fully raised on the hydraulic linkage, the body required for work is locked rigidly to the main frame by a slide bar so that, as the plough is lowered into the work, the idle body is automatically raised well clear of the ground. At the end of the furrow, the complete plough is once again lifted, the slide bar, or latch, moved over to lock the other beam to the main frame and then the plough lowered into the work again. Mounting of the implement to the tractor is effected through the three-point hydraulic linkage in the same manner as for a fixed plough, the only addition being the pulley bracket which is hitched over the ram shaft. Alterations to pitch or level, therefore, can be made by adjusting the lift links from the tractor seat in the normal manner. Accurate and constant ploughing depth is determined by a large-diameter land wheel located centrally and operated by a screw mechanism. Lateral furrow-width adjustment is effected by a further screw control arranged to operate an eccentric cross-shaft hitch, both depth and lateral-control handles being accessible from the tractor seat. To ensure that exactly the same ploughing depth is obtained with both bodies, independent pitch adjustment is provided by means of eccentric securing bolts. Either knife or disc coulters are available and all coulters and skims are fully adjustable for varying working conditions. At present, the plough is fitted with 16-in. deep-digger bodies with three-ply hardened-steel mould boards, steel shares and chilled-cast-iron points.

AUTOMATIC TRACTOR HITCH

Messrs. David Brown were also showing the automatic hitch illustrated in Fig. 8, opposite. This mechanism has been designed for use with trailers and trailed implements fitted with ring-type towing eyes. As will be seen from the illustration, the mechanism consists of a towing frame the side members of which are pivoted to the rear of the tractor. The frame is supported by the implement-lift links and, in operation, the tractor is backed up to the trailer so that the hook fitted to the towing frame comes immediately below the trailer towing eye. The hydraulic lift is then operated, the hook, as a consequence, making contact with, and raising the towing eye of the trailer. The eye is prevented from disengaging with the hook by a rigid-type latch. This forms an integral part of a vertical member pivoted at its base to the towing frame at a point just above the hook and at its head to a tube which holds the member at the correct relative distance from the tractor. The vertical member together with the latch piece and distance tube are clearly visible in the illustration and it will be appreciated from a study of this that, as the towing frame rises, the tip of the hook eventually will make contact with the latch piece thus effectively preventing the towing eye from jumping out of the hook. To prevent the weight imposed by the trailer on the towing frame from being taken by the hydraulic piston and cylinder assembly, a bolt is incorporated at the rear of the tractor which engages with a slot in the nearside lifting arm.

TIPPING TRAILER WITH AUTOMATIC HITCH

A somewhat different method of achieving the same end was being demonstrated by Taskers of Andover (1932), Limited, Andover, Hampshire. In this case, the automatic-coupling device is installed on the trailer drawbar. It is illustrated in Fig. 11, above, which shows the mechanism installed on a Tasker 3-ton hydraulically-tipped trailer. The essential part of the device is a towing eye arranged to slide up and down a slotted steel ramp on the drawbar. When the trailer is detached, the drawbar rests on the ground and the towing eye assembly is held at the top of its ramp by means of a pawl and ratchet mechanism. To connect the trailer to the tractor, the latter is backed towards the trailer until the towing hook is close to the ramp and just above the slot. The pawl is then released from the ratchet thus allowing the towing eye to slide down the ramp to make contact with the hook. The tractor is then driven forward, the towing eye, as a consequence, being pulled to the front of the drawbar where it is automatically locked in position. To release the trailer, the procedure is reversed, the towing eye, which is first unlocked from its position at the front of the drawbar, sliding up the ramp as the tractor is reversed thus gently lowering the drawbar to the ground. The trailer is of straightforward design, consisting of a triangulated welded-steel frame on which is installed a body of steel-framed wooden construction. There are no springs and the axle, which is machined from the solid, is fitted with taper-roller bearings. Malleable-iron hubs are used and the bearings are protected on the inside by leather seals and on the outside by dust caps. Girling 12-in. by 1⅝-in. internal-expanding brakes are fitted and are operated from the tractor-driver's position by a hand lever installed on the drawbar. The hydraulic-tipping gear is operated from the tractor but a hand pump can be fitted for independent tipping when the trailer is either disconnected from the tractor or is being used with a towing vehicle not fitted with hydraulic gear. If required, the trailer can be supplied with a hand-operated screw tipping gear. The overall length of the complete trailer is 14 ft. and the body dimensions are: length, 10 ft.; width, 6 ft. 4 in.; and height of sides, 1 ft. 6 in. The floor height, laden, is 2 ft. 9 in. and the unladen weight approximately 13 cwt.

Fig. 11 Automatic-coupling device fitted to a 3-ton trailer. The towing-eye can be slid along the bar to bring it into a convenient position for linking to the tractor draw hook.

VERTICAL OIL ENGINES

Messrs. Ruston and Hornsby, Limited, Lincoln, have made the Royal Show the occasion for introducing their new range of Class YB Diesel engines. These engines provide outputs of from 4 brake horse-power to 12 brake horse-power at 1,000 r.p.m. to 1,500 r.p.m. and in accordance with the company's usual practice, are of exceptionally rugged construction. Two types are available, namely, the 1/YB and the 2 YB, the former being a single-cylinder unit and the latter a twin-cylinder unit. The 2 YB model is illustrated in Fig. 10 opposite from which it will be seen that the unit is of very clean design. In general, the arrangement of the YB class of engines follows established principles. They are four-cycle compression ignition units with open-type combustion-chambers and employing direct injection. In each case the crankcase and cylinder block are separate castings of close-grained cast iron, the block being fitted with removable wet-type liners.

The crankshaft is machined from a steel stamping and it is supported in pre-finished steel-backed white-metal lined main bearings. Low-expansion silicon-aluminium alloy pistons are fitted and each is fitted with three pressure rings and two oil-control rings. The pistons are anodised on the crown, lands and ring grooves. A cast-iron camshaft is used, the cams forming an integral part of the shaft. Overhead valves are employed and these are operated in the usual manner through pivot rods and rocking levers. The connecting rods are machined from H-section steel stampings and have white-metal lined big-end bearings and copper-lead lined little-end bearings. The rods are designed so that they can be withdrawn through the cylinder bores.

UNIT FUEL PUMPS

Unit fuel pumps of the "Helix" type are fitted and these operate in conjunction with multi-hole injectors. The pump, or pumps, are operated from the camshaft through rocking levers and the engine speed is controlled by a centrifugal governor installed on the end of the camshaft. Lubrication is by a submerged gear-type oil pump, the lubricating system incorporating a full-flow filter. Water cooling is employed and the engine temperature is controlled thermostatically. The drive can be taken from either end of the crankshaft or at half engine speed from an extension of the camshaft. The single-cylinder unit develops 4 h.p. at 1,000 r.p.m., 5 h.p. at 1,250 r.p.m. and 6 h.p. at 1,500 r.p.m., the maximum governed speed. For the twin-cylinder model, the outputs are 8 h.p., 10 h.p. and 12 h.p. at 1,000 r.p.m., 1,250 r.p.m. and 1,500 r.p.m. respectively. The approximate weights are 491 lb. for the single-cylinder model and 686 lb. for the twin-cylinder model, these weights excluding cooling equipment, fuel tank and other accessories. For the single-cylinder version, the length overall is 2 ft. 2½ in. and the height 2 ft. 7¼ in. For the two-cylinder model, these dimensions are 2 ft. 8 in. and 2 ft. 10¾ in. respectively. Additional equipment available with these engines includes 12-volt electric-starting gear, radiators, water tanks, flexible couplings, and clutch power-take-offs.

To be continued

AUTOMATIC WEIGHING AND RECORDING

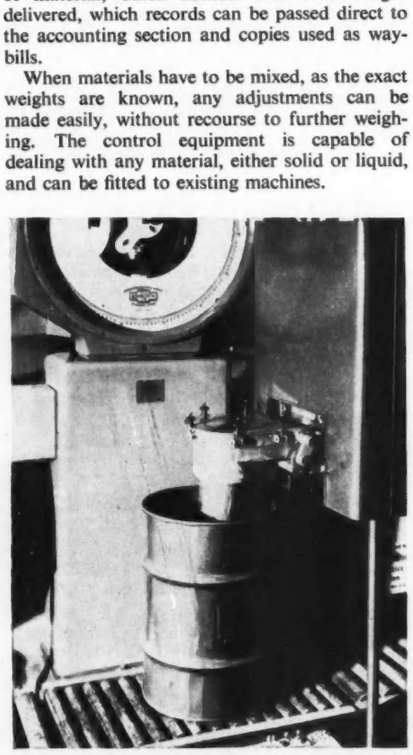
Electronic Attachment for Standard Machine

An electronically-controlled equipment for weighing material into containers and registering the exact weight has been introduced by the British Tabulating Machine Company, Limited, 17 Park-lane, London, W.1, and was shown at the recent Mechanical Handling Exhibition. It is particularly designed for continuous processes and where the amount weighed out requires to be known accurately. The weighing head is shown in the illustration below.

On the spindle of the weighing-machine pointer there is a slotted disc which interrupts a beam of light falling on a photo-electric cell. This forms a scanning device which transmits to the control unit pulses corresponding to the weight registered by the scales. The control unit then operates an electric typewriter which prints the weight registered on either a separate slip or a continuous ribbon of paper. These basic operations can be modified to suit each particular application.

In the case illustrated, the container, of a nominal capacity of 56 lb., is first weighed empty and the weight recorded. Then the material is fed in, first at a high rate up to, for example, 54 lb., and then more slowly until the 56 lb. is reached. The flow is then cut off and the exact weight recorded. Cut-off is timed to allow for the material actually in transit, and the quantity weighed into the container is correct within 2 oz. of the nominal 56 lb., an error of $\pm$ 0·22 per cent. By using suitable recording and accounting machines, printed records can be made giving serial number, tare, exact weight of material, batch number and total weight delivered, which records can be passed direct to the accounting section and copies used as waybills.

When materials have to be mixed, as the exact weights are known, any adjustments can be made easily, without recourse to further weighing. The control equipment is capable of dealing with any material, either solid or liquid, and can be fitted to existing machines.



With this equipment, 56 lb. of material is weighed into the drum with an error of $\pm$ 2 oz. and the exact weight recorded. The quantity can be varied according to the container used.

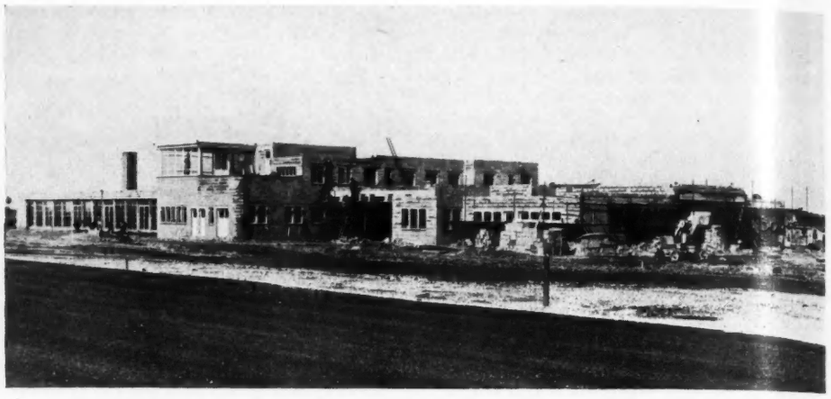


Fig. 1 The terminal building in an advanced state of construction. On both sides of the central portion – which houses customs, etc., below, and the control tower and offices above – are covered ways communicating with the loading apron for the outgoing and incoming vehicles.

AIRPORT FOR CROSS-CHANNEL VEHICLE FERRY

LAYOUT AND EQUIPMENT OF SILVER CITY AIRWAYS "FERRYFIELD"

On Tuesday, July 13, one of Silver City Airways' fleet of Bristol Superfreighter aircraft took off on the first car-ferry flight to Le Touquet from a new privately-owned airport, Ferryfield, which is situated near Lydd on the Denge marsh (at the southern tip of the Romney Marshes). A new company, Ferry Airports, Limited, has been formed by Silver City's parent company, Britavia Limited, to own and operate Ferryfield, to whom Silver City will pay rental and landing fees in the normal way. The company expect to operate cross-channel vehicle air-ferry services at 20-minute intervals between Ferryfield and Le Touquet. At present, the Calais and Ostend ferries will continue to be operated from Lympne airfield.

RAPID AND ECONOMICAL CONSTRUCTION

Ferryfield is a unique airport in that it is believed to be the first in the United Kingdom to be designed and constructed by an air line, and the first in the world designed specially for handling vehicle traffic. From an engineering viewpoint the interest of Ferryfield lies in the speed and economy with which it has been completed, in less than nine months from the drawing-up of preliminary plans and seven months from the start of operations on the site. The main contractors were Richard Costain Limited, Dolphin-square, London, S.W.1. The cost of construction has been stated to be less than £300,000.

In selecting the site it was necessary that it should be no further away from the French air-ferry terminal at Le Touquet than is Lympne airport (47 miles), that it should have a better weather record than Lympne, that it should be at sea level with completely unobstructed approaches, and finally that it should provide good road and rail access facilities. All these considerations are fulfilled in the Romney Marsh site which, moreover, provides space for later expansion and development.

As may be seen from the layout, Fig. 2, opposite, Ferryfield comprises two hard runways, an administrative and terminal building, car parks, workshops and service station. It is planned to build a "Motel" to open in the spring of 1955. Ultimately, hangars will be added to permit part of the aircraft maintenance to be transferred from the company's present overhaul base at Blackbushe.

The principal runway is 120 ft. wide and has an effective operational length of more than 4,050 ft. The second runway has an effective length of 3,500 ft. The runways have been built to their present lengths solely to suit the operation of the Bristol aircraft used on the air ferry service but, as already mentioned, there is space for extension.

SOIL-CEMENT STABILISED RUNWAYS

The site selected was rich in shingle and gravel, and for this reason the contractors decided to adopt soil-cement stabilisation for constructing the runways and hardstanding. All the materials, other than cement and bituminous products, were available within the perimeter of the airfield.

Before work could begin on the site, a 1¼-mile access road had to be built; ¼ million cub. yards of shingle were excavated and placed on the line of the runways to form a base. About 26 earth-moving machines were used at the site.

The bottom fill was compacted, using steel sledges carrying high-frequency vibrators driven by Diesel engines. Frequencies of the order of 6,000 cycles per minute were employed. The compacted base was then topped with a 9-in. layer of selected gravel, found on the site and graded to the required camber.

The cement was then spread mechanically, sprayed with water and mixed *in situ*, and compacted by single-pass soil-cement stabilising machines to form a 6-in. compacted flexible pavement with a reasonably level surface. Two soil stabilisers were employed – a P. and H. machine imported from the United States, and British equipment constructed by Rotary Hoes, Limited, Hornden, Essex. A detailed description of the latter, and a discussion of the technique of soil stabilisation, can be found on page 54 of our 177th volume (January 8, 1954). The cost of this form of construction is considerably less than that of rigid-pavement runways.

Where the runway cut through shingle ridges the 6-in. stabilised gravel pavement was laid directly on the shingle subsoil. Where the runway was layed above clay a gravel base not less than 27 in. thick was interposed between the pavement and the clay.

In areas where abrasive action by aircraft is likely to be excessive the stabilised pavement is covered by 1½ in. of tarred stone. The main landing and take-off portions of the runways are sprayed with two layers of tar and gritted with fine sand and small stones.

The airfield has no special drainage system but where existing ditches cross any of the works they are carried in concrete pipes. A number of vertical drains were also constructed to pass water through the clay layer in places where there was any risk of local surface flooding.

The tarmac area is located in the western apex formed by the intersection of the runways. It faces the terminal building and has parking accommodation for six Bristol Superfreighter aircraft; permanent tie-down points are sunk into the concrete. In normal wind conditions aircraft will complete their landing run within a few yards of one of three taxi strips leading to the tarmac.

TERMINAL BUILDING

All the administrative and traffic facilities, customs and immigration are housed in a single building 300 ft. long and 100 ft. deep. The two-storey centre part of the building is divided from the single-storey left and right wings by two covered access ways for vehicles arriving or leaving by air; the customs and immigration offices, in the lower storey of the centre block, are adjacent to these ways. In the upper storey are the control tower, radio and teleprinter rooms and administrative offices. Our photograph opposite shows this building in the course of construction.

The operations rooms and meteorological offices, bonded stores and transit freight shed are grouped in the left wing. The right wing houses the passenger reception lounge, traffic counters, licensed buffet, restaurant and all-electric kitchen, and also the boiler house and switch room.

The building itself is of light-section steel-framed construction on heavily reinforced concrete strip foundations. Waterproof cement is employed in the latter since the standing water level is only 18 in. below the ground surface. The outer cladding comprises two concrete-block shells tied together with metal ties. The roof is of Halcrete slabs covered with bituminised felt. The outer surface of the building is to be finished in Snowcem. An oil furnace has been installed to heat the building.

FLYING AIDS INCLUDE RADAR

Ferryfield is being equipped with comprehensive navigational and airport aids. Communications equipment includes a Decca 424 airfield control radar and a medium-frequency directional beacon, as well as three very-high-frequency radio transmitters, and three receivers which will provide continuous communication between flying control and aircraft. Certain of the company's airfield transport will also be fitted with very-high-frequency radio.

The Decca radar, which is capable of locating and identifying aircraft up to 16 miles away, provides an important additional safety measure, in particular for bad-weather operation. A similar aid is shortly being installed at Le Touquet, the French terminal of the service, which will in effect give the flying controllers at both terminals the ability to " track " Silver City aircraft over the greater part of their short cross-Channel routes. For night flying, the approach to the main runway is marked by a sodium-light funnel leading to runway lights at 60-yard intervals.

Flying control at Ferryfield will be linked by teleprinter directly to the Ministry of Transport and Civil Aviation's " master " flying control unit at Uxbridge. Other teleprinters will link the airport with Lympne and with the company's London headquarters.

Aircraft refuelling will be carried out by 500-gallon Thomson fuelling vehicles which will work in pairs so as to reduce refuelling time. Bulk storage of Shell aviation spirit will be in three 10,000-gallon surface storage tanks, located near the service station for motorists on the airport access road. For aircraft towing, tarmac liaison and fire control, there will be new Douglas Tugmasters, each capable of towing more than 25 tons. For emergencies, there are also a fire engine and an ambulance fitted with radio.

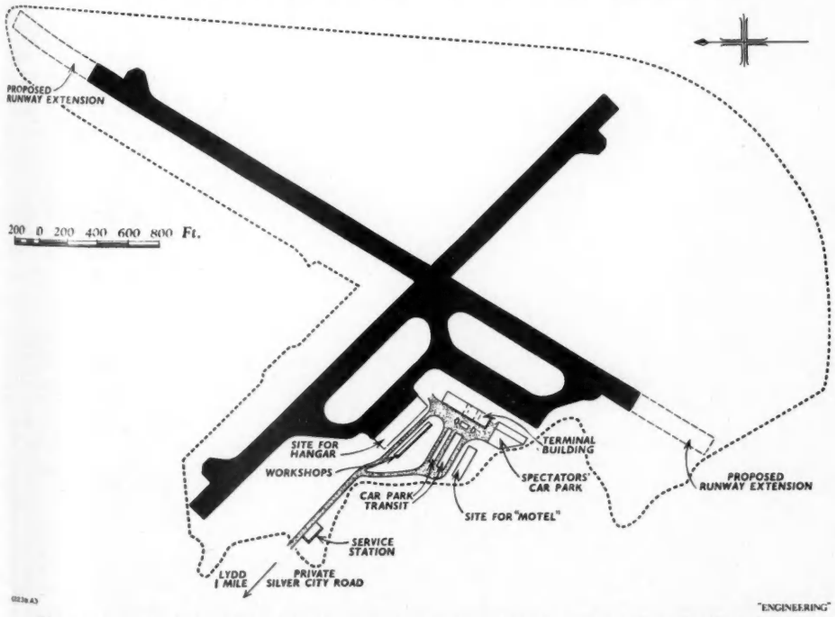


Fig. 2. Layout of Ferryfield, which has been designed specially for the air-ferrying of vehicles.

LAUNCHES AND TRIAL TRIPS

M.S. " HAMINA."—Single-screw cargo vessel, built and engined by John Lewis and Sons, Ltd., Aberdeen, for A/S William Hansen Rederi II, Bergen, Norway. Main dimensions: 275 ft. between perpendiculars by 44 ft. by 21 ft. 9 in.; deadweight capacity, about 3,100 tons. Lewis-Doxford opposed-piston oil engine. Launch, June 3.

M.S. " NORFOLD."—Single-screw oil tanker, built and engined by the Götaverken Shipyard, Gothenburg, Sweden, for Hvalfanger A/S Vestfold (Managers: Johan Rasmussen & Co.), Sandefjord, Norway. Main dimensions: 550 ft. overall by 66 ft. by 39 ft. 3 in.; deadweight capacity, about 17,390 tons on a draught of 30 ft. 2 in. Götaverken nine-cylinder two-stroke single-acting Diesel engine, developing 6,750 b.h.p. at 112 r.p.m. Loaded speed, 15 knots. Delivered, June 3.

M.S. " OLIVEAN."—Single-screw trawler, built by Cochrane and Sons, Ltd., Selby, Yorkshire, for Sir Thomas Robinson and Son (Grimsby) Ltd., Grimsby. Main dimensions: 115 ft. between perpendiculars by 25 ft. by 12 ft.; gross tonnage, 275. Four-cylinder direct-reversing Diesel engine, developing 575 b.h.p. at 225 r.p.m. in service, constructed by British Polar Engines, Ltd., Glasgow, and installed by the Drypool Engineering and Dry Dock Co., Ltd., Hull. Launch, June 3.

M.S. " JOURNALIST."—Single-screw cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for the Charente Steam Ship Co., Ltd. (Managers: Thos. and Jas. Harrison, Ltd.), Liverpool. First vessel of an order for two. Main dimensions: 464 ft. overall by 59 ft. 6 in. by 37 ft. 8 in.; deadweight capacity, 9,700 tons. Doxford four-cylinder opposed-piston oil engine. Service speed, 13½ knots. Delivered, June 3.

SHIP No. 237.—Single-screw oil tanker, built by John Crown and Sons, Ltd., Sunderland, for Rolf Wigand Skipsrederi, Bergen, Norway. Constructed in two parts; after part now completed and will be attached to fore part (launched on January 5) in dry dock. Main dimensions of completed vessel: 516 ft. between perpendiculars by 73 ft. by 41 ft. 1 in.; deadweight capacity, 18,250 tons on a draught of 30 ft. 6 in. Sulzer nine-cylinder single-acting two-stroke oil engine, developing 6,300 b.h.p. at 125 r.p.m. in service, installed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Service speed, 14½ knots. Launch of after part, June 4.

SHIP No. 494.—Grain-elevating pontoon, built by the Goole Shipbuilding and Repairing Co., Ltd., Goole, for Simon Handling Engineers Ltd., Stockport. Main dimensions: 87 ft. by 37 ft. 6 in. by 15 ft. Launch, June 5.

M.S. " BERGEBOSS."—Twin-screw oil tanker, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for Skibsaktieselskapene Snefonn og Bergehus, Oslo, Norway, in conjunction with Sig. Bergesen d. y. & Co., Stavanger, Norway. Fourth tanker built for these owners. Main dimensions: 625 ft. between perpendiculars by 86 ft. by 45 ft. 9 in.; deadweight capacity, 32,900 tons on a draught of 34 ft. 6 in.; oil-tank capacity, 1,563,413 cub. ft. Two B. and W. six-cylinder single-acting two-stroke Diesel engines, together developing 13,800 i.h.p. Speed, 15½ knots, fully loaded. Delivered, June 9.

M.S. " WHAKATANE."—Single-screw cargo vessel, with accommodation for six passengers, built by Alexander Stephen and Sons, Ltd., Linthouse, Glasgow, for the New Zealand Shipping Co., Ltd., London, E.C.3. Main dimensions: 472 ft. overall by 62 ft. 9 in. by 39 ft. 6 in.; draught, 30 ft. 6 in.; gross tonnage, 8,750; general cargo space, 400,000 cub. ft.; insulated cargo space, 95,000 cub. ft. Doxford six-cylinder opposed-piston Diesel engine, developing 7,100 b.h.p. at 114 r.p.m. Service speed, 16 knots. Delivered, June 10.

S.S. " CLAN ROBERTSON."—Single-screw cargo vessel, with accommodation for twelve passengers, built by the Greenock Dockyard Co., Ltd., Greenock, for the Clan Line Steamers, Ltd., London, E.C.3. First vessel of a new series. Main dimensions: 465 ft. between perpendiculars by 65 ft. 6 in. by 39 ft. 7¼ in. to upper deck; deadweight capacity, 10,100 tons on a mean draught of 27 ft. 3 in.; gross tonnage, 7,775. Reaction steam turbines with double-reduction gearing, developing 9,400 s.h.p. in service, constructed by Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne; and two oil-fired steam-generating units, constructed by Babcock and Wilcox, Ltd., London, E.C.4. Machinery installed by John G. Kincaid & Co., Ltd., Greenock. Service speed, about 17 knots. Trial trip, June 24 and 25.

Labour Notes

RECORD NUMBER IN EMPLOYMENT

At the end of May, the number of people in civil employment in Great Britain was 22,427,000, the highest total ever recorded in peace-time. This total, which included persons engaged in industry, commerce, and services of all kinds, was due to an increase during the month of 85,000, of whom 34,000 were men and boys, and 51,000 were women and girls.

Employment in the basic industries, which comprise mining, quarrying, agriculture, fishing, transport, communications, gas, electricity and water, was increased by 16,000 persons, of whom 15,000 found work in the agricultural and fishing industries.

In the manufacturing group of industries, which includes, among others, the engineering, metal-goods, precision-instrument, metal-manufacturing, chemical, textile, clothing, food, drink and tobacco trades, there was a total increase in employment of 29,000 net during the month. The rise in total was due principally to an increase of 13,000 in the food, drink and tobacco industries, and of 10,000 in the engineering, metal-goods and precision-instrument industries.

The greatest increases, however, took place outside these two main employment groups. Persons employed in professional, financial and miscellaneous services rose by 20,000, from 3,963,000 in April, to 3,983,000 in May. During the same period, there was an advance of 11,000 in the number of people engaged in the distributive trades and of 10,000 in those employed on building and contracting work.

OVERTIME, SHORT-TIME AND UNEMPLOYMENT

Nearly 1,500,000 persons were reported to the Ministry of Labour and National Service, by firms making returns for the week ended May 29, as being employed on overtime work, nearly 60,000 more than at the end of February last. The number of workpeople engaged on short-time on May 29 was just over 40,000, slightly more than at the end of February.

Seasonal work resulted in a decrease of 49,900 in the number of persons registered as unemployed, between May 10 and June 14, last. That was in excess of the decrease which is normal at this time of the year. In all, some 239,500 persons were registered with the Ministry as unemployed on June 14, but this number included 12,900 people who were only temporarily out of work.

Unemployment on June 14 was estimated to represent 1·1 per cent. of the total number of employees, compared with 1·4 per cent. in mid-May and 1·4 per cent. in mid-June last year. On June 14, the number of people who had been disengaged for eight weeks or longer was 108,500, about 48 per cent. of the persons wholly out of work. This was the lowest figure recorded by the Ministry since December, 1951.

HIGH LEVEL OF PRODUCTION

References to recent improvements in Britain's economic position, the rate at which industrial production and exports had risen, and the removal of many war-time controls were made by Mr. R. A. Butler, the Chancellor of the Exchequer, in an address at Gloucester on July 10.

A most encouraging feature of the past few months, Mr. Butler said, was the important part played by the export trade in securing the increase in industrial productivity. Activity was high in all branches of British industry, and particularly so in the building trade.

The nation's external position had improved considerably in the first half of the present year, during which reserves had been increased by about £170 million. Although it was too early to give accurate figures in respect to the balance of payments for the past six months, there was good reason for believing that the overall surplus on current account would compare very favourably with that obtained during the first half of last year.

In the lifetime of the present Government, there had been a substantial advancement in the prospects for peace and employment. Wages and social security had greatly improved. Production was at the highest level on record.

Prices, too, had been kept fairly stable during the past twelve months. It was true that some prices had risen, but, on the other hand, there were many that had been lowered.

PENSIONS FOR RAILWAY EMPLOYEES

Agreement has been reached between the railway unions and the British Transport Commission for the introduction of a contributory pension scheme on October 1 for the Commission's male employees. An announcement to this effect was made by Mr. A. T. Lennox-Boyd, the Minister of Transport and Civil Aviation, in the House of Commons on July 7.

The scheme is in two parts, the principal of which provides that whole-time employees aged from 21 to 45, who have completed at least one year's service, shall receive a pension at the minimum retiring age of 65. The pension payable under this section will amount to 30*s.* a week after 40 years' service, but will be less for shorter periods.

Present employees who can complete 20 years' service before they are 65 will have a six-month option to join the scheme, but entry will be compulsory for staff engaged after October 1 next. Employees now in the Commission's service, and aged 52 or over, may join this part of the scheme, and will be given such credit at the Commission's expense as may be necessary to secure a minimum pension of 9*s.* 9*d.* a week at the age of 65.

Members will pay a contribution of 1*s.* 8*d.* a week on entry at 21 years of age, rising to 2*s.* 5*d.* a week on entry at 54 years of age or above.

The other part of the scheme is intended to provide supplementary pensions for certain senior grades who have joined the main section. They will pay additional contributions, ranging from 8*d.* to 11*d.* a week, according to age at entry, and will receive a further 10*s.* a week pension after 35 years' membership. This amount, also, will be proportionately less for shorter periods.

FURTHER PROVISIONS OF THE SCHEME

Men remaining at work after the age of 65 will have the amounts due to them under the main part of the scheme increased by one-fifteenth, and those due under the second part by one-tenth, for each year of additional service, up to a maximum of five years.

When men are forced to retire early owing to ill-health they will receive a proportion of the maximum pension provided that they have been members of the scheme for ten years or longer. Employees leaving for health reasons after less than ten years' membership will have their contributions returned to them with interest.

Representatives of persons dying in the Commission's service will receive a lump sum, approximately equal to the return of the members' contributions with compound interest.

A transfer value will be paid to the Commission's salaried staff scheme when a member of the wage-grades' scheme is promoted to salaried rank. Provision is also made to meet the case of men who leave the Commission's service and enter other employment in respect of which there are reciprocal arrangements for the transfer of pension rights.

The scheme will be administered by a committee of 20, half of whom will be appointed by the Commission and half by the trade unions. In the event of changes taking place in pension conditions under the National Insurance Act, the Commission undertakes to review the scheme and, if necessary, to ask the Minister to amend the rules.

The scheme will be applicable to all male wage grades of the Commission in the service of British Railways, the London Transport Executive, the docks and inland waterways division, the hotels and catering services, and at the Commission's headquarters.

The National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, the Transport and General Workers' Union, and the Confederation of Shipbuilding and Engineering Unions are in complete agreement with the scheme.

WELSH STEELWORKS DISPUTE

Some 300 coke-oven employees at the Margam steelworks of the Steel Company of Wales, Limited, ceased work on July 5, as the result of a wage dispute. The strike, which is unofficial, seems likely to hold up steel production at Port Talbot, as well as the supply of gas to industries and homes throughout West Wales.

When the strike commenced, staff employees, comprising clerks, draughtsmen, engineers and administrative officials, were drafted to the works to keep the ovens working as long as possible. It was announced last Friday that the strikers would maintain safety-level production at the ovens, but the company stated, at the same time, that it had had to expedite its arrangements for the gradual reduction of coke output.

The company claims that the difficulty arose owing to the men's rejection of a wage offer. The strikers contend that the dispute is in connection with a wage bonus for which they have been negotiating constitutionally, through their union, for the past 18 months.

STRIKES AT NAVAL AIRCRAFT YARDS

A union demarcation dispute has arisen at the Royal Naval aircraft yard at Sydenham, Belfast, where the Amalgamated Engineering Union withdrew some 300 fitters in May, on the ground that work previously undertaken by operatives belonging to the A.E.U. had been allotted to members of another organisation.

On July 5, members of the union employed at the Royal Naval aircraft yard at Donibristle, near Dumfermline, Fifeshire, ceased work in sympathy, and efforts have since been made to bring out men at the Admiralty's aircraft yard at Fleetlands, near Portsmouth.

An official announcement issued by the Admiralty states that the dispute concerns the erection of simple prefabricated metal racks and shelves for storage purposes and has no connection with work on aircraft. The A.E.U. members claim that this is work for fitters, but the Admiralty contends that the work is performed at all its establishments by skilled labourers.

Since the strike first began, the Admiralty Industrial Council has been endeavouring to reach a settlement. The Admiralty states that it has no intention whatever of employing skilled labourers on what is properly fitters' work.